PASCAL DISCOVERING GEOMETRY.

CURIOSITIES

OF

HUMAN NATURE.

CRICHTON.

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CURIOSITIES

OF

HUMAN NATURE:

BY THE AUTHOR OF

Goodrich, Sam. G.,

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STEREOTYPED BY
GEORGE A. CURTIS,
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'It would much conduce to the magnanimity and honor of man, if a collection were made of the extraordinaries of Human Nature, principally out of the reports of history—that is, what is the last and highest pitch to which man's nature, of itself, hath ever reached, in all the perfection of the mind and body. If the wonders of Human Nature and virtues, as well of mind as of body, were collected into a volume, they might serve as a calendar of human triumphs."

Lord Bacon.

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CURIOUS BIOGRAPHIES.

ZERAH COLBURN.

AMONG the intellectual prodigies which sometimes appear to excite the wonder and astonishment of mankind, Zerah Colburn was certainly one of the most remarkable. He was born at Cabot, Vermont, Sept. 1st, 1804. He was the sixth child of his parents, who were persons in low circumstances and of little education. He was regarded as the most backward of the children till he was about six years old, when he suddenly attracted attention by the display of his astonishing powers.

In August, 1810, when his father, Abia Colburn, was one day employed at a joiner's work-bench, Zerah was on the floor, playing among the chips; suddenly, he began to say to himself,—5 times 7 are 35—6 times 8 are 48, &c. His father's attention was immediately arrested by hearing this, so unexpected in a child so young, and who had hitherto possessed no advantages, except perhaps six weeks' attendance at

the district school, that summer. He therefore left his work, and turning to the child, began to examine him in the multiplication table. He thought it possible that Zerah had learnt this from the other boys; but finding him perfect in the table, his attention was more deeply fixed, and he asked the product of 13×97, to which 1261 was instantly given as the answer. He now concluded that something unusual had actually taken place; indeed, he has often said he should not have been more surprised if some one had risen up out of the earth and stood erect before him.

It was not long before a neighbor rode up, and stopping at the house, was informed of the singular occurrence. He desired to be a witness of the fact. Zerah was called, and the result of the examination astonished every one present. The strange phenomenon was now rapidly spread throughout the town. Though many were inclined to doubt the correctness of the reports they heard, a personal examination attested their truth. Thus the story originated, which within the short space of a year found its way not only through the United States, but also reached Europe, and extorted expressions of wonder from foreign journals of literature and science in England, France and other countries.

Very soon after the discovery of his remarkable powers, many gentlemen, at that time possessing influence and public confidence throughout the state, being made acquainted with the circumstances, were desirous of having such a course adopted as might most directly lead to a full development of Zerah's talents, and their application to purposes of general

utility. Accordingly, it was proposed that Mr. Colburn should carry his son to Danville, to be present during the session of the court. This was done, and the boy was very generally seen and questioned by the judges, members of the bar, and others.

The legislature of Vermont being about to convene at Montpelier, Mr. Colburn was advised to visit that place with his son, which they did in October. Here large numbers had an opportunity of witnessing his calculating powers, and the conclusion was general that such a thing had never been known before. Many questions, which were out of the common limits of arithmetic, were proposed, with a view to puzzle the child, but he answered them correctly; as, for instance, —which is the most, twice twenty-five, or twice five and twenty? Ans. Twice twenty-five. Which is the most, six dozen dozen, or half a dozen dozen? Ans. Six dozen dozen. Somebody asked him how many black beans would make five white ones. Ans. Five, if you skin them! Thus it appeared that the boy could not only compute and combine numbers readily, but that he also possessed a quickness of thought, somewhat uncommon among children, as to other things.

Soon after this, Mr. Colburn took his son to other large towns, and at last to Boston. Here the boy excited the most extraordinary sensation, and several gentlemen of the highest standing proposed to undertake his education. The terms, though very liberal, were not equal to the high-raised expectations of the father. The offer was therefore refused, and Mr. Colburn proceeded to the southern cities, exhibiting

his son in public, his performances everywhere exciting the utmost wonder.

The author of these pages had an opportunity of seeing Zerah Colburn, at this period. He was a lively, active boy, of light complexion, his head being rather larger than that of boys generally at his age. He was then six years old, and had the manners common to children of his age. He was playful, even while performing his calculations. The quickness and precision with which he gave answers to arithmetical questions was amazing. Among those proposed to him at Boston, in the autumn of the year 1810, were the following:

What is the number of seconds in 2000 years? The answer, 63,072,000,000, was readily and accurately given. Another question was this: Allowing that a clock strikes 156 times in a day, how many times will it strike in 2000 years? The child promptly replied, 113,800,000 times.

What is the product of 12,225, multiplied by 1,223? Ans. 14,951,175. What is the square of 1,449? Ans. 2,099,601. Suppose I have a corn-field, in which are seven acres, having seventeen rows to each acre, sixty-four hills to each row, eight ears on a hill, and one hundred and fifty kernels on an ear; how many kernels in the corn-field? Ans. 9,139,200.

It will be recollected that the child who answered these questions was but six years old; that he had then had no instruction whatever in arithmetic; that he could neither read nor write, and that he performed these immense calculations by mental processes, wholly

his own. His answers were usually given, and the calculations performed, while engaged in his sports, and the longest process seemed hardly to divert his mind from his amusements. His answers were often made almost as soon as the question was proposed, and in most cases before the process could be performed on paper.

His faculty for calculation seemed to increase, and as he became acquainted with arithmetical terms, his performances were still more remarkable. In June, 1811, he was asked the following question: If the distance between Concord and Boston be sixty-five miles, how many steps must I take in going this distance, supposing each step to be three feet? The answer, 114,400 steps, was given in ten seconds. He was asked how many days and hours had elapsed since the Christian era commenced. In twenty seconds he replied, 661,015 days, 15,864,360 hours.

Questions still more difficult were answered with similar promptitude. What sum multiplied by itself will produce 998,001? In less than four seconds he replied 999. How many hours in thirty-eight years, two months, and seven days? The answer, 334,488, was given in six seconds.

These extraordinary performances, witnessed by thousands of people, and among them persons of the highest standing, were soon reported in the papers, and attracted scarcely less attention in Europe than in this country. In England, particularly, great curiosity was expressed, and the plan of taking young Colburn thither was suggested. After some deliberation, this project was resolved upon; and in the

spring of 1812, the father and son embarked at Boston for Liverpool, where they landed on the 11th of May. They proceeded to London, and taking rooms at Spring Gardens, commenced their exhibition.

Great numbers came to witness the performances of the boy, among whom Zerah, in his Life, enumerates the dukes of Gloucester and Cumberland, Lord Ashburton, Sir James Mackintosh, Sir Humphrey Davy, and the Princess Charlotte. The latter, attended by her tutor, the bishop of Salisbury, remained a full hour, and asked a number of questions. Among the rest was this: What is the square of 4001? The answer, 16,008,001, was immediately given. The duke of Cambridge asked the number of seconds in the time elapsed since the commencement of the Christian era, 1813 years, 7 months, 27 days. The answer was correctly given, 57,234,384,-000.

An extraordinary interest was excited in London in respect to this remarkable youth, and schemes for giving him an education suited to his turn of mind were suggested. At a meeting of several distinguished gentlemen, to mature some plan of this sort, various questions were proposed to the child. He multiplied the number eight by itself, and each product by itself, till he had raised it to the sixteenth power, giving, as the almost inconceivable result, 281,474,976,710,656. He was asked the square root of 106,929, and before the number could be written down, he answered 327. He was then requested to name the cube root of 268,336,125, and with equal *facility* and promptness he replied, 645.

A likeness of the young prodigy, drawn by Hull and engraved by Meyer, was now published, and sold at a guinea each. Many were sold, and a considerable profit was realized. Another scheme was now started, —a memoir of the child,—and among the committee to superintend its publication, were Sir James Mackintosh, Sir Humphrey Davy and Basil Montague. Several hundred subscribers were obtained, but, though many paid in advance, for some reason or other the work was never published. Young Colburn and his father now made a tour to Ireland and Scotland. Among his visitors in Scotland, were Dugald Stewart, Professor Playfair, Doctor Brewster and Doctor Macknight. In March, 1814, they returned to London. By the advice of friends, they now proceeded to Paris, where they arrived in July, 1814.

Zerah was carefully examined before the French Institute. It is curious that on this occasion he was longer in giving his answers than ever before; probably owing to some embarrassment. His performances, however, excited here, as everywhere else, the greatest astonishment. La Place, the author of the Méchanique Celeste, was present. Guizot received the youth at his house, and expressed in his behalf the liveliest interest.

Such was the feeling excited, that a project was set on foot for giving Zerah an education at the Royal College of Henry IV. Nothing was wanting but the sanction of the king; but at the precise moment when measures were in progress to secure this object, Bonaparte came back from Elba, sweeping everything before him. The Bourbons fled, and the em-

peror was reinstated upon his throne. Application was now made to him in behalf of young Colburn; his assent was obtained, and on the 13th May, 1815, he entered the seminary, which was now restored to its original title, the Lyceum Napoleon.

Mr. Colburn had, in England, Scotland and Paris, obtained a large number of subscribers to the memoir. Having placed his son in the Lyceum, he went to London to attend to the publication of the work. Here he met with bitter disappointment. His agent, who had been authorized to collect the money, had received about one third of the whole subscriptions, and appropriated the money to his own use. As he was poor, the whole sum was irretrievably lost. At the same time, Mr. Colburn found that his former friends were greatly chagrined to find that the French government, more liberal than themselves, had made provision for his son. Under this influence, the project of the memoir was abandoned, and a new scheme was proposed, the object of which was to raise two hundred pounds a year for six years, to defray the expenses of the boy's education.

While Mr. Colburn was pursuing this scheme, Zerah was at the Lyceum at Paris, which now became the theatre of the most interesting events. The battle of Waterloo was fought, Napoleon fled, and the French army retreated toward the capital. To this point, the hostile armies were now directing their march, and the citizens of Paris were roused for its defence. Every effort was made to strengthen the walls and throw up entrenchments. The scholars at the Lyceum received permission to join in this work, and

with enthusiastic ardor, heightened by their sympathy for Napoleon, they went to their tasks, crying, "*Vive l'Empereur.*" Our little mathematician was among the number, and if he could have multiplied forts as easily as he managed figures, Paris would, doubtless, have been saved. But the fortune of war decided otherwise. Paris was overwhelmed, Napoleon dethroned, and Louis XVIII. restored.

Zerah Colburn might have continued at the Lyceum; but his foolish father, having embraced the London scheme, proceeded to Paris, and carried him thence again to London, where they arrived February 7, 1816.

The scheme which had excited Mr. Colburn's hopes, was, however, a mere illusion. His friends were worn out with his importunities, and, doubtless, disgusted with his fickleness. They were dissatisfied by discovering that while he wished to obtain a provision for his son, he desired also that some emolument, sufficient for his own wants, should come to himself. The result was, that both the father and son were reduced to a state of poverty. While attempting, by means scarcely better than beggary, to obtain transient support, they chanced to call upon the Earl of Bristol, who received them kindly, and expressed great interest in the youthful calculator. He invited them to his country residence at Putney, whither they went, and spent several days. The result of this fortunate acquaintance was, that the Earl made a provision of six hundred and twenty dollars a year for young Colburn's education at Westminster school, where he was regularly entered on

the 19th September. At this period, he was a few days over twelve years old.

It now seemed that better fortunes had dawned upon this gifted, but still unfortunate boy; but these were soon clouded by disappointment. The custom of fagging existed in this school, as in all the higher seminaries of England. By this system, the boys of the under classes were required to be waiters and servants of those in the upper classes. Zerah was subjected to this arrangement, and a youth in the upper school was pitched upon for his master. This was the son of a baronet, Sir John L. Kaye.

Soon after he had been initiated into these menial duties, one of the upper scholars called upon him to perform some servile task. This he accomplished, but not to the satisfaction of his employer. He therefore complained to young Kaye, his proper master, whose wrath being greatly excited, he fell upon poor Zerah, twisted his arm nearly out of joint, and, placing him in a helpless situation, beat his shoulder black and blue. Zerah went to his father, who immediately proceeded to Mr. Knox, the usher. The latter expressed regret for the abuse Zerah had received, but when the father claimed exemption for his son from the custom of fagging, the usher positively refused compliance. Mr. Colburn enjoined it upon his son by no means to submit to this system of drudgery again, and departed. In the evening, he was called upon to clean a pair of shoes. This he refused; whereupon, a number of the larger boys, who had gathered around him, first threatened, and then beat him without mercy, until at last he complied. All

this occurred under the same roof where the usher then was. In the morning, the father came, and appealing to him, was treated with contempt. As he was going across the yard to see Dr. Page, the head master, the boys yelled at him from their windows, calling him Yankee; doubtless, deeming it the most opprobrious of epithets. The final result of this matter was, that Zerah was exempted from the custom of fagging, though no relaxation of the custom, generally, was made in the school.

Zerah continued at Westminster, spending his vacations with the Reverend Mr. Bullen, Lord Bristol's chaplain, at the village of Danton. His father, in the mean time, picked up the means of subsistence, partly by boarding his son and a few other scholars, and partly by contributions. At length, the Earl, who was now in Germany, made an arrangement for the removal of Zerah from the Westminster school to the exclusive charge of Mr. Bullen. Mr. Colburn objected to this, and wrote accordingly to Lord Bristol. The latter persisted in his plan, and in order to reconcile the father to it, offered him fifty pounds a year for his own personal use. With stubbornness, amounting to infatuation, he rejected the generous offer, and withdrew his son from the Westminster school, and the patronage of his noble friend.

Young Colburn had spent two years and nine months at the Westminster seminary; where his progress in the acquisition of languages and other studies was extremely rapid. Euclid's Elements of Geometry were mastered with ease; but it is a curious fact that while the boy was fascinated with arithme-

tical calculations, as he advanced into the abstruser portions of mathematics, his taste revolted from a pursuit that was dry and repulsive.

Again the father and son were afloat in the sea of London. What was to be done now? The education of his son was, doubtless, an object to Mr. Colburn; but, with blind selfishness, he seems to have thought more of turning him to account as a means of raising money. With this view he proposed that he should go upon the stage; no doubt supposing that the youth's notoriety would render him available in this capacity. He was put in training, under the care of Charles Kemble. After four months' tuition, he appeared at Margate in the character of Norval. His reception was tolerably flattering, but he obtained no compensation. Mr. Colburn now determined to exhibit his son in his new profession, in Scotland and Ireland; but being almost entirely destitute of money, they were obliged to take a steerage passage in a vessel, and subsist upon hard fare. They arrived at Edinburgh, but received no encouragement in the theatrical line. Mr. Colburn called upon his former friends, and they contributed to his immediate relief. They now proceeded by canal-boat to Greenock, and thence in a vessel to Belfast. Here they found a strolling company of players, with whom an arrangement was made for Zerah's appearance at Londonderry, whither the party were about to proceed; to that place father and son journeyed on foot. Here the latter performed in some inferior characters, and soon returned with the band to Belfast. At this place he played the part of Richard the Third—but alas! even this

master-stroke of policy failed. The father and son pushed on to Dublin, but they could get no engagement at the theatre.

The inventive resources of Abia Colburn were not yet exhausted. Zerah must now turn author—and the future Methodist preacher must write a play! The subject chosen was that of Tasso's Jerusalem Delivered. The drama was composed—and we believe it was actually performed. But, alas! says Zerah, in his honest, modest book—"it never had any merit or any success."

After an absence of two months, the wanderers returned to London. A long period of inaction follows, during which Zerah wrote plays, which were never printed or performed, and the father picked up a precarious living by levying contributions upon his former friends. These were at last worn out with his importunities, and finally, one of the best of them deliberately turned Zerah out of doors, when he came upon some errand from his father.

Deprived of all other means save that of begging, which was now a poor resource, the youth obtained employment in October, 1821, as an usher in a school, and soon after established one on his own account. This afforded so poor a support, that still another effort was made to raise funds, ostensibly to provide for his permanent relief. To obtain subscribers to this proposal, Zerah went to Edinburgh, Glasgow and Belfast. At the former place, Mr. Combe took a cast of his head, seeking thereby to throw light upon his phrenological theories. He returned to London, with little success, and resumed his school.

The health of his father now began to give way. Unhappily, he had, from the first discovery of his son's extraordinary gifts, looked upon them with mercenary feelings—as a source of revenue. It is true he had a father's love for his child—and in this respect, Zerah, in the simple memoir of his own life, does his parent more than justice; but still, it was this short-sighted selfishness which made him convert his child's endowments into a curse to him, to his friends, and Zerah himself. His expectations had been lifted to such a pitch, that nothing could satisfy them. The most generous offers fell short of what he felt to be his due; liberality was turned, in his mind, to parsimony—and even friends were regarded as little short of enemies. His sanguine temper led him constantly to indulge high hopes, which were as constantly doomed to disappointment. Such a struggle could not always last. His mind was torn with thoughts of his home and family neglected for twelve years; of his life wasted; his prospects defeated; of fond dreams, ending at last in failure, shame and poverty. He failed gradually, and on the 14th February, 1824, he died. A few days after, the body was consigned to the tomb, and Zerah, in his life, notices the fact that John Dunn Hunter was among the mourners. We mention this, as coinciding with the account we have given in this volume of that extraordinary character.

Zerah continued in London for a few months, in the employment of Mr. Young, in making astronomical calculations. He had, however, a desire, enforced by his father's death-bed injunctions, to return to his

country, and his mother, at Cabot. Again aided by his friend, Lord Bristol, he was provided with necessary means, and in June, 1824, he arrived at New York. On the third of July he approached his mother's door. He found there an elderly woman, and being uncertain who it was, he asked if she could tell him where the widow Colburn lived. "I am she," was the reply.

The mother of Zerah Colburn was a remarkable woman. During the long absence of her husband, with a family of eight children, and almost entirely destitute of property, she had sustained the burthen with indomitable energy. She wrought with her own hands, in house and field; bargained away the little farm for a better; and, as her son says, "by a course of persevering industry, hard fare, and trials such as few women are accustomed to, she has hitherto succeeded in supporting herself, besides doing a good deal for her children."

Zerah Colburn was now unable to offer much aid to his mother or the family. He found employment for a time as a teacher; but his mind at last was impressed with religious views, and after some vicissitudes of life, and many fluctuations of feeling, he finally adopted the Methodist faith, and became a humble but sincere preacher of that sect. With pious, patient assiduity he continued in this career for a number of years. He published a modest memoir of his life and adventures, from which we have gathered the greater part of our account,—and at last became professor of the Greek, Latin, French and Spanish languages, as well as of classical literature, in the "Ver-

mont University," at Norwich. At this place he died, March 2d, 1840, in the thirty-eighth year of his age.

Whoever has carefully attended to the facts stated in the early part of this notice, will be prepared to admit that Zerah Colburn was one of the most astonishing intellectual prodigies that has ever appeared. Totally uninstructed in figures, at the age of six years, he was able to perform mental operations which no man living, by all the training of art, is able to accomplish. It had been stated by scientific men, that no rule existed for finding the factors of numbers; yet this child discovered a rule by which he ascertained results of this kind, accessible only to skilful arithmeticians. In the London prospectus, the following facts, in relation to this point, are stated, which cannot fail to excite astonishment.

At one of his exhibitions, among various questions, it was proposed that he should give the factors of 171,395—and he named the following as the only ones: 5×34279; 7×22485; 59×2905; 83×2065; 35×4897; 295×581; 413×415. He was then asked to give the factors of 36,083; but he immediately replied that it had none, which is the fact, it being a prime number. "It had been asserted and maintained by the French mathematicians that 4294-967297, was a prime number; but the celebrated Euler detected the error by discovering that it was equal to $641\times6{,}700{,}417$. The same number was proposed to this child, who found out the factors by the mere operation of his mind."

Great pains were taken to discover the processes by which this boy performed his operations. For a

long time he was too ignorant of terms, and too little accustomed to watch the operations of his mind, to do this. He said to a lady, in Boston, who sought to make him disclose his mode of calculation, "I cannot tell you how I do these things. God gave me the power." At a subsequent time, however, while at the house of Mr. Francis Bailey, in London, upon some remark being made, the boy said suddenly, and without being asked—"I will tell you how I extract roots." He then proceeded to tell his operations. This is detailed in Zerah's book; but it in no degree abates our wonder. The rule does not greatly facilitate the operation; it still demands an effort of mind utterly beyond the capacity of most intellects; and after all, the very rule itself was the invention of a child.

As he did not at first know the meaning of the word factor, when desired to find the factors of a particular number, the question was put in this form—"What two numbers multiplied together will produce such a number?" His rule for solving such problems was sought for with much curiosity. At last this was discovered. While in Edinburgh, in 1813, he being then nine years old, he waked up one night, and said suddenly to his father—"I can tell you how I find the factors!" His father rose, obtained a light, and wrote down the rule, at Zerah's dictation.

It appears that when he came to maturity, these faculties did not improve; and after a time he was even less expert in arithmetical calculations than when he was ten years old. It is probable, his whole mind was weakened, rather than strengthened, by the

peculiar circumstances of his life. As a preacher, he was in no way distinguished. He says this in his book, with simple honesty; and seems at a loss to understand the design of Providence in bestowing upon him so stupendous a gift, which, so far as he was able to discover, had produced no adequate results.

He suggests, indeed, a single instance, in which an atheist in Vermont, who witnessed his performances in childhood, was induced to reflect upon the almost miraculous powers of the mind, and led to the conclusion that it must have an intelligent author. He saw that which was as hard to believe, as much beyond the routine of experience, as any miracle—and hence fairly concluded that miracles could be true. By this course of reflection he was induced to reject his infidelity, and afterwards became a sincere Christian.

This, we doubt not, was one of the designs of Providence, in the bestowment of Zerah Colburn's wonderful gifts. But their use should not be confined to an individual case. If there is argument for God in a flower, how much more in a child of Zerah Colburn's endowments? What infidelity can withstand such an instance, and still say, there is no God? And farther, let us reflect upon the noble powers of the mind, and rejoice, yet with fear and trembling, that we are possessors of an inheritance, which, at God's bidding, is capable of such mighty expansion.

The history of Zerah Colburn may teach us one thing more—that the gifts of genius are not always sources of happiness to the possessor; that mental affluence, like worldly riches, often brings sorrow,

rather than peace to the possessor; and that moderate natural gifts, well cultivated, are generally the most useful in society, and most conducive to the happiness of the possessor.

Zerah Colburn, at eight years of age.

BARATIER.

John Philip Baratiere was a most extraordinary instance of the early and rapid exertion of mental faculties. He was the son of Francis Baratiere, minister of the French church at Schwoback, near Nuremberg, where he was born, January 10, 1721. The French was his mother tongue, and German was the language of the people around him. His father talked to him in Latin, and with this he became familiar; so that, without knowing the rules of grammar, he, at four years of age, talked French to his mother, Latin to his father, and High Dutch to the servants and neighboring children, without mixing or confounding the respective languages.

About the middle of his fifth year, he acquired a knowledge of the Greek; so that in fifteen months he perfectlv understood all the Greek books in the Old and New Testament, which he translated into Latin. When five years and eight months old, he entered upon Hebrew; and in three years more, was so expert in the Hebrew text, that, from a Bible without points, he could give the sense of the original in Latin or French, or translate, extempore, the Latin or

French versions into Hebrew. He composed a dictionary of rare and difficult Hebrew words; and about his tenth year, amused himself, for twelve months, with the rabbinical writers.

He now obtained a knowledge of the Chaldaic, Syriac and Arabic; and acquired a taste for divinity and ecclesiastical antiquity, by studying the Greek fathers of the first four ages of the church. In the midst of these occupations, a pair of globes coming into his possession, he could, in eight or ten days, resolve all the problems upon them; and in January, 1735, at the age of fourteen, he devised his project for the discovery of the longitude, which he communicated to the Royal Society of London, and the Royal Academy of Sciences at Berlin!

In June, 1731, he was matriculated in the university of Altorf; and at the close of 1732, he was presented by his father at the meeting of the reformed churches of the circle, at Franconia; who, astonished at his wonderful talents, admitted him to assist in the deliberations of the synod; and, to preserve the memory of so singular an event, it was registered in their acts. In 1734, the Margrave of Brandenburg, Anspach, granted this young scholar a pension of fifty florins; and his father receiving a call to the French church at Stettin, in Pomerania, young Baratiere was, on the journey, admitted master of arts. At Berlin, he was honored with several conversations with the king of Prussia, and was received into the Royal Academy.

Towards the close of his life, he acquired a considerable taste for medals, inscriptions, and antiquities,

metaphysical inquiries, and experimental philosophy. He wrote several essays and dissertations; made astronomical remarks and laborious calculations; took great pains towards a history of the heresies of the Anti-Trinitarians, and of the thirty years' war in Germany. His last publication, which appeared in 1740, was on the succession of the bishops of Rome. The final work he engaged in, and for which he had gathered large materials, was Inquiries concerning the Egyptian Antiquities. But the substance of this blazing meteor was now almost exhausted; he was always weak and sickly, and died October 5th, 1740, aged nineteen years, eight months, and sixteen days. Baratier published eleven different pieces, and left twenty-six manuscripts, on various subjects, the contents of which may be seen in his Life, written by Mr. Formey, professor of philosophy at Berlin.

GASSENDI

Pierre Gassendi, one of the most famous naturalists and philosophers of France, was born at Chantersier, January 22, 1592, of poor parents. They were, however, wise and virtuous people, and perceiving the extraordinary gifts of their son, did everything in their power to promote his education. At the age of four years, young Pierre used to declaim little sermons of his own composition, which were quite interesting. At the age of seven, he would steal away from his parents, and spend a great part of the night in observing the stars. This made his friends say he was born an astronomer. At this age, he had a dispute with some boys, whether it was the moon or the clouds that moved so rapidly; to convince them that it was the latter, he took them behind a tree, and made them take notice that the moon kept its situation between the same leaves, while the clouds passed on.

This early disposition to observation led his parents to place him under the care of the clergyman of the village, who gave him the first elements of learning.

Gassendi and the Boys.

His ardor for study then became extreme: the day was not long enough for him; and he often read a great part of the night by the light of the lamp that was burning in the church of the village, his family being too poor to allow him candles for his nocturnal studies. He often took only four hours sleep in the night. At the age of ten, he harangued his bishop in Latin, who was passing through the village on his visitation; and he did this with such ease and spirit, that the prelate exclaimed—"That lad will, one day or other, be the wonder of his age." The modest and unassuming conduct of Gassendi gave an additional charm to his talents.

In his manners, this remarkable youth was in general silent, never ostentatiously obtruding upon others, either the acuteness of his understanding, or the eloquence of his conversation; he was never in a hurry to give his opinion before he knew that of the persons who were conversing with him. When men of learning introduced themselves to him, he was contented with behaving to them with great civility, and was not anxious to surprise them into admiration. The entire tendency of his studies was to make himself wiser and better; and to have his intention more constantly before his eyes, he had all his books inscribed with these words, *Sapere aude;* "Dare to be wise."

Such was Gassendi's reputation, that at sixteen he was called to teach rhetoric at the seminary of Digne; in 1614, he was made professor of theology in the same institution; and two years after, he was invited to fill the chair of divinity and philosophy at Aix.

After passing through various promotions, and publishing several works of great merit on philosophical subjects, Gassendi went at last to Paris, where he gained the friendship of Cardinal Richelieu, and shared the admiration of the learned world with the famous philosopher, Descartes.

Being appointed a professor of mathematics in the College Royal of Paris, he gave his attention to astronomical subjects, and greatly increased his reputation. After a life devoted to science, in which his achievements were wonderful, he died at Paris, October 14, 1655, aged sixty-three years. Distinguished by his vast learning, his admirable clearness of mind, the diversity of his acquirements, the calmness and dignity of his character, and the amiableness of his manners, Gassendi was alike one of the brightest ornaments of his age and of human nature.

PASCAL.

Blaise Pascal "perhaps the most brilliant intellect that ever lighted on this lower world," was born at Clermont, in the province of Auvergne, on the 19th of June, 1623. He was descended from one of the best families in that province. As soon as he was able to speak, he discovered marks of extraordinary capacity. This he evinced, not only by the general pertinency and acuteness of his replies, but also by the questions which he asked concerning the nature of things, and his reasonings upon them, which were much superior to what is common at his age. His mother having died in 1626, his father, who was an excellent scholar and an able mathematician, and who lived in habits of intimacy with several persons of the greatest learning and science at that time in France, determined to take upon himself the whole charge of his son's education.

One of the instances in which young Pascal displayed his disposition to reason upon anything, is the following. He had been told that God rested from his labors on the seventh day, and hallowed it, and had commanded all mankind to suspend their labor and

do no work on the Sabbath. When he was about seven years of age, he was seen, of a Sabbath morning, measuring some blades of grass. When asked what he was doing, he replied that he was going to see if the grass grew on Sunday, and if God ceased working on the Sabbath, as he had commanded mankind to do!

Before young Pascal had attained his twelfth year, two circumstances occurred, which deserve to be recorded, as they discovered the turn, and evinced the superiority, of his mind. Having remarked one day, at table, the sound produced by a person accidentally striking an earthenware plate with a knife, and that the vibrations were immediately stopped by putting his hand on the plate, he became anxious to investigate the cause of this phenomenon; he employed himself in making a number of experiments on sound, the results of which he committed to writing, so as to form a little treatise on the subject, which was found very correct and ingenious.

The other occurrence was his first acquisition, or, as it might not be improperly termed, his invention of geometry. His father, though very fond of mathematics, had studiously kept from his son all the means of becoming acquainted with this subject. This he did, partly in conformity to the maxim he had hitherto followed, of keeping his son superior to his task; and partly from an apprehension that a science so engaging, and at the same time so abstracted, and which, on that account, was peculiarly suited to the turn of his son's mind, would probably absorb too

much of his attention, and stop the progress of his other studies, if he were at once initiated into it.

But the activity of an inquisitive and penetrating mind is not to be so easily restrained. As, from respect to his father's authority, however, the youth had so far regarded his prohibition as to pursue this study only in private, and at his hours of recreation, he went on for some time undiscovered. But one day, while he was employed in this manner, his father accidentally came into the room, unobserved by Pascal, who was wholly intent on the subject of his investigation. His father stood for some time unperceived, and observed, with the greatest astonishment, that his son was surrounded with geometrical figures, and was then actually employed in finding out the proportion of the angles formed by a triangle, one side of which is produced; which is the subject of the thirty-second proposition in the First Book of Euclid.

The father at length asked his son what he was doing. The latter, surprised and confused to find his father was there, told him he wanted to find out this and that, mentioning the different parts contained in that theorem. His father then asked how he came to inquire about that. He replied, that he had found out such a thing, naming some of the more simple problems; and thus, in reply to different questions, he showed that he had gone on his own investigations, totally unassisted, from the most simple definition in geometry, to Euclid's thirty-second proposition. This, it must be remembered, was when Pascal was but twelve years of age.

His subsequent progress perfectly accorded with this extraordinary display of talent. His father now gave him Euclid's Elements to peruse at his hours of recreation. He read them, and understood them, without any assistance. His progress was so rapid that he was soon admitted to the meetings of a society of which his father, Roberval, and some other celebrated mathematicians were members, and from which afterwards originated the Royal Academy of Sciences, at Paris.

During Pascal's residence with his father at Rouen, and while he was only in his nineteenth year, he invented his famous arithmetical machine, by which all numerical calculations, however complex, can be made by the mechanical operation of its different parts, without any arithmetical skill in the person who uses it. He had a patent for this invention in 1649. His studies, however, began to be interrupted when he reached his eighteenth year by some symptoms of ill health, which were thought to be the effect of intense application, and which never afterwards entirely quitted him; so that he was sometimes accustomed to say, that from the time he was eighteen, he had never passed a day without pain. But Pascal, though out of health, was still Pascal; ever active, ever inquiring, and satisfied only with that for which an adequate reason could be assigned. Having heard of the experiments instituted by Torricelli, to find out the cause of the rise of water in fountains and pumps, and of the mercury in the barometer, he was induced to repeat them, and to make others, to satisfy himself upon the subject.

In 1654, he invented his arithmetical triangle, for the solution of problems respecting the combinations of stakes, in unfinished games of hazard; and long after that, he wrote his Demonstrations of the Problems relating to the Cycloid; besides several pieces on other subjects in the higher branches of the mathematics, for which his genius was probably most fitted. Pascal, though not rich, was independent in his circumstances; and as his peculiar talents, his former habits, and the state of his health, all called for retirement, he adopted a secluded mode of life. From 1655, he associated only with a few friends of the same religious opinions with himself, and lived for the most part in privacy in the society of Port Royal.

At this period, the Catholics being divided into Jesuits and Jansenists, Pascal, being of the latter, published his famous Provincial Letters. These are so distinguished for their admirable wit, their keen argument, and their exquisite beauty of style, as to have even extorted praise from Voltaire and D'Alembert. He also wrote other pieces against the Jesuits, marked with great talent.

Pascal's health, however, continued to decline; and it is probable that his mind suffered in consequence. Though his life had been singularly blameless, still he seemed to be pained with a sense of inward sin. He was accustomed to wear an iron belt around his waist, in which were sharp points, upon which he would strike his elbows, or his arms, when any unholy passion crossed his mind. He continued to practise charity toward all mankind, and severe austerities to himself, until at last he was attacked with

sickness, and on the 19th of August, 1662, he died. His last words were, "May God never forsake me!"

The latter part of his life was wholly spent in religious meditations, though he committed to paper such pious thoughts as occurred to him. These were published after his death, under the title of "Thoughts on Religion and other Subjects." They have been greatly admired for their depth, eloquence and Christian spirit.

Pascal.

GROTIUS.

Hugo Grotius, celebrated for his early display of genius and learning, as well as for his adventures and writings in after life, was born at Delft, in Holland, April 10, 1583. He had the best masters to direct his education, and from childhood, was not only distinguished by the great brilliancy of his mind, but also by his application to study. Such was his progress, that, at eight years of age, he composed Latin elegiac verses of great cleverness, and at fourteen, he maintained public theses in mathematics, law, and philosophy with general applause. His reputation by this time was established, and he was mentioned by the principal scholars of the age, as a prodigy of

learning, and as destined to make a conspicuous figure in the republic of letters.

In 1598, he accompanied Barnevelt, ambassador extraordinary of the Dutch Republic, in a journey to France, where he was introduced to Henry IV., who was so pleased with his learning, that he presented him with his picture and a gold chain. While in France, he took the degree of doctor of laws. The following year he commenced practice as an advocate, and pleaded his first cause at Delft. In the same year, though then only seventeen, he was chosen historiographer to the United Provinces, in preference to several learned men who were candidates for that office.

Grotius now rapidly rose in rank and reputation: he published several works of great merit, and was appointed to various public offices of high trust. On one occasion he was sent by the government to England to attend to some negotiations, at which time he became acquainted with King James II. But serious religious difficulties now began to agitate Holland. In 1618, a synod met at Dort to take these into consideration. They proceeded to condemn the Arminian doctrines, and to banish all the preachers who upheld them. Barnevelt, who was a celebrated statesman, Grotius, and Hoogurbetz, advocated these sentiments; they were tried and condemned; the first was executed and the two others were sentenced to perpetual imprisonment.

In his prison of Louvestien, Grotius found consolation in literary pursuits. His wife, after much entreaty, was permitted to visit him, and she did

everything which the most devoted affection could suggest, to alleviate his confinement. She was accustomed to send him books in the chest which was conveyed out and in, with his linen: this was carefully examined by the jailer, for a time, but finding nothing amiss, he became less suspicious and careful.

Taking notice of this, the wife of Grotius, after he had been confined about two years, devised a scheme for his escape. She pretended to have a large quantity of books to send away. Having a small chest of drawers, about three feet and a half long, she packed her husband into it, and it was carried out by two soldiers, who supposed they were transporting a quantity of books. The chest was now put on a horse, and carried to Gorcum, where the illustrious prisoner was set at liberty.

Disguised in the dress of a mason, with a rule and a trowel in his hand, he fled to Antwerp, which was not under the government of the Stadtholder, Prince Maurice, who had caused his imprisonment. Here he wrote to the State's General of Holland, asserting his innocence of any wrong, in the course he had taken, and for which he had been deprived of liberty. He afterwards went to Paris, where he received a pension from the king.

After the death of Prince Maurice, his confiscated property and estates were restored, and he returned to Holland; but he still found such a spirit of rancor against him, among the principal persons, that he left the country forever, and took up his residence at Hamburgh. Here he received the most flattering proposals from the kings of Portugal, Spain, Den-

mark, and other countries, who admired his great abilities, and desired him to seek shelter and protection with them.

He finally adopted Sweden as his country, and becoming the queen's ambassador to France, he proceeded, in that character, to Paris, where, for eight years, he sustained the interests of his patron with firmness and dignity. At last, being weary of public life, he solicited his recall. In August, 1648, he embarked for Lubec, where he intended to reside; but, meeting with a dreadful storm, he was driven upon the coast of Pomerania, and obliged to take a land journey of sixty miles, in order to reach Rostock, during which he was exposed to the rain and inclement weather. A fever soon set in, and at midnight, on the 28th of August, the illustrious stranger died.

Grotius has left behind him many works, some of them of great value. His treatise upon the "Truth of the Christian Religion," written in Latin, like his other productions, is one of the best defences of that system which has ever appeared. His work on the law of Peace and War, is still of high authority. We must look upon Grotius as a man of great acuteness, as well as vast expanse of mind. He was, indeed, in advance of his generation, and, like other patriots and philanthropists, who see farther than those around them, he was an object of hatred and disgust, for those very things which in an after age brought him the homage and gratitude of mankind. In an intolerant age, Grotius was in favor of toleration, and this alone was a crime which his generation could not forget or forgive.

NEWTON.

Sir Isaac Newton, the greatest of natural philosophers, was born at Woolsthorpe, in Lincolnshire, December 25, 1642, old style. At his birth he was so small and weak that his life was despaired of. On the death of his father, which took place while he was yet an infant, the manor of Woolsthorpe became his heritage. His mother sent him, at an early age, to the village school, and in his twelfth year, to the seminary of Grantham.

While here he displayed a decided taste for mechanical and philosophical inventions; and avoiding the society of other children, provided himself with a collection of saws, hammers, and other instruments, with which he constructed models of many kinds of machinery. He also made hour-glasses, acting by the descent of water. A new windmill, of a peculiar construction, having been erected in the town, he studied it until he succeeded in imitating it, and placed a mouse inside, which he called the miller.

Some knowledge of drawing being necessary in these operations, he applied himself, without a master, to the study; and the walls of his room were


ISAAC NEWTON
VAD. DEL.

covered with all sorts of designs. After a short period, however, his mother took him home, for the purpose of employing him on the farm and about the affairs of the house. She sent him several times to market, at Grantham, with the produce of the farm. A trusty servant was sent with him, and the young philosopher left him to manage the business, while he himself employed his time in reading. A sun-dial, which he constructed on the wall of the house at Woolsthorpe, is still shown. His irresistible passion for study and science finally induced his mother to send him back to Grantham. Here he continued for a time, and was entered at Trinity College, Cambridge, 1660.

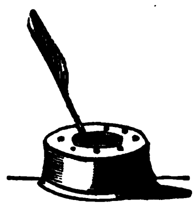
At the latter place he studied mathematics with the utmost assiduity. In 1667, he obtained a fellowship; in 1669, the mathematical professorship; and in 1671, he became a member of the Royal Society. It was during his abode at Cambridge that he made his three great discoveries, of fluxions, the nature of light and colors, and the laws of gravitation. To the latter of these his attention was first turned by his seeing an apple fall from a tree. The Principia, which unfolded to the world the theory of the universe, was not published till 1687. In that year also Newton was chosen one of the delegates to defend the privileges of the university against James II.; and in 1688 and 1701 he was elected one of the members of the university. He was appointed warden of the mint in 1696; he was made master of it in 1699; was chosen president of the Royal Society in 1703; and was knighted in 1705. He died March 20, 1727.

His "Observations on the Prophecies of Daniel and the Apocalypse" appeared in 1733, in quarto. "It is astonishing," says Dr. Hutton, "what care and industry Newton employed about the papers relating to chronology, church history, &c.; as, on examining them, it appears that many are copies over and over again, often with little or no variation." All the works of this eminent philosopher were published by Dr. Samuel Horsley, in 1779, in five volumes, quarto; and an English translation of his "Philosophæ Naturalis Principia Mathematicæ," is extant.

The character of this great man has been thus drawn by Mr. Hume, in his history of England. "In Newton, Britain may boast of having produced the greatest and rarest genius that ever rose for the ornament and instruction of the human species. Cautious in admitting no principles but such as were founded on experiment, but resolute to adopt every such principle, however new or unusual; from modesty, ignorant of his superiority over the rest of mankind, and thence less careful to accommodate such reasonings to common apprehensions; more anxious to merit than acquire fame:—he was from these causes long unknown to the world; but his reputation at last broke out with a lustre, which scarcely any writer, during his own lifetime, had ever before attained. While Newton seemed to draw off the veil from some of the mysteries of nature, he showed at the same time some of the imperfections of the mechanical philosophy; and thereby restored her ultimate secrets to that obscurity in which they ever did and ever will remain."

The remains of Sir Isaac Newton were interred in Westminster Abbey, where a magnificent monument is erected to his memory, with a Latin inscription, concluding thus:—"Let mortals congratulate themselves that so great an ornament of human nature has existed." His character is shown, by Dr. Brewster, to have been that of the humble and sincere Christian. Of nature, antiquity, and the Holy Scriptures, he was a diligent, sagacious, and faithful interpreter. He maintained by his philosophy the dignity of the Supreme Being, and in his manners he exhibited the simplicity of the Gospel. "I seem to myself," he said, "to be like a child, picking up a shell here and there on the shore of the great ocean of truth." He would hardly admit that he had a genius above other men, but attributed his discoveries to the intentness with which he applied to the study of philosophy. We cannot better close our notice of this great man, than in the words of Pope:

"Nature and nature's laws lay hid in night—
God said, 'let Newton be'—and all was light!"



MAGLIABECCHI.

ANTONY MAGLIABECCHI was born at Florence, on the 29th of October, in the year 1633. His parents were so poor as to be well satisfied when they got him into the service of a man who sold greens. He had not yet learned to read, but he was perpetually poring over the leaves of old books, that were used as waste paper in his master's shop. A bookseller who lived in the neighborhood, observed this, and knowing that the boy could not read, asked him one day what he meant by staring so much at pieces of printed paper? He said, that he did not know how it was, but that he loved it of all things; that he was very uneasy in the business he was in, and should be the happiest creature in the world if he could live with him, who had always so many books about him.

The bookseller was pleased with this answer; and at last told him, that if his master were willing to part with him, he would take him. Young Magliabecchi was highly delighted, and the more so, when his master, agreeably to the bookseller's desire, gave him leave to go. He went, therefore, directly to his new business. He had not long been there, before he could find out any book that was asked for, as readily as the bookseller himself. In a short period he had learned to read, and then he was always reading when he could find time.

He seems never to have applied himself to any particular study. A love of reading was his ruling passion, and a prodigious memory his great talent. He read all kinds of books, almost indifferently, as they came into his hands, and that with a surprising quickness; yet he retained not only the sense, but often the words and the very manner of spelling.

His extraordinary application and talents soon recommended him to Ermina, librarian to the Cardinal de Medicis, and Marmi, the Grand Duke's librarian. He was by them introduced to the conversation of the learned, and made known at court. He now began to be looked upon everywhere as a prodigy, particularly for his unbounded memory.

In order to make an experiment in respect to this, a gentleman of Florence, who had written a piece, which was to be printed, lent the manuscript to Magliabecchi. Sometime after it had been returned, he came to the librarian with a melancholy face, and told him that by some accident he had lost his manuscript; and seemed almost inconsolable, entreating Magliabecchi, at the same time, to endeavor to recollect as much of it as he possibly could, and write it down. Magliabecchi assured him he would do so, and on setting about it, wrote down the whole, without missing a word.

By treasuring up everything he read, in this wonderful manner, or at least the subject, and all the principal parts of the books he ran over, his head became at last, as one of his acquaintance expressed it, "an universal index, both of titles and matter."

By this time, Magliabecchi was grown so famous for the vast extent of his reading, and his amazing retention of what he had read, that it began to grow common amongst the learned to consult him when they were writing on any subject. Thus, for instance, if a priest was going to compose a panegyric upon any favorite saint, and came to communicate his design to Magliabecchi, he would immediately tell him who had said anything of that saint, and in what part of their works, and that, sometimes, to the number of above a hundred authors. He would tell them not only who had treated of their subject designedly, but of such, also, as had touched upon it incidentally, in writing on other subjects. All this he did with the greatest exactness, naming the author, the book, the words, and often the very number of the page in which the passage referred to was inserted. He did this so often, so readily, and so exactly, that he came at last to be looked upon almost as an oracle, for the ready and full answers that he gave to all questions proposed to him in respect to any subject or science whatever.

It was his great eminence in this way, and his almost inconceivable knowledge of books, that induced the Grand Duke, Cosmo the third, to make him his librarian. What a happiness must it have been to one like Magliabecchi, who delighted in nothing so much as reading, to have the command and use of such a collection of books as that in the Duke's palace! He was also very conversant with the books in the Lorenzo library; and had the keeping of those of Leopoldo, and Francisco Maria, the two cardinals of Tuscany.

Magliabecchi had a local memory, too, of the places where every book stood, in the libraries which he frequented; he seems, indeed, to have carried this even farther. One day the Grand Duke sent for him to ask whether he could get him a book that was particularly scarce. "No, sir," answered Magliabecchi, "for there is but one in the world, and that is in the Grand Signior's library at Constantinople; it is the seventh book on the second shelf, on the right hand, as you go in."

Though Magliabecchi lived so sedentary a life, with such an intense and almost perpetual application to books, yet he arrived to a good old age. He died in his eighty-first year, on the 14th of July, 1714. By his will he left a very fine library, of his own collection, for the use of the public, with a fund to maintain it; and whatever should remain over, to the poor.

In his manner of living, Magliabecchi affected the character of Diogenes; three hard eggs, and a draught or two of water, were his usual repast. When his friends went to see him, they generally found him lolling in a sort of fixed wooden cradle, in the middle of his study, with a multitude of books, some thrown in heaps, and others scattered about the floor, around him. His cradle, or bed, was generally attached to the nearest pile of books by a number of cobwebs: at the entrance of any one, he used to call out, "Don't hurt my spiders!"

JAMES CRICHTON.

JAMES CRICHTON, commonly called 'The Admirable,' son of Robert Crichton, of Eliock, who was Lord Advocate to King James VI., was born in Scotland, in the year 1561. The precise place of his birth is not mentioned, but he received the best part of his education at St. Andrews, at that time the most celebrated seminary in Scotland, where the illustrious Buchanan was one of his masters. At the early age of fourteen, he took his degree of Master of Arts, and was considered a prodigy, not only in abilities, but in actual attainments.

It was the custom of the time for Scotchmen of birth to finish their education abroad, and serve in some foreign army, previously to entering that of their own country. When he was only sixteen or seventeen years old, Crichton's father sent him to the Continent. He had scarcely arrived in Paris, which was then a gay and splendid city, famous for jousting, fencing, and dancing, when he publicly challenged all scholars and philosophers to a disputation at the College of Navarre. He proposed that it should be carried on in any one of twelve specified languages, and have relation to any science or art, whether practical or theoretical. The challenge was accepted; and, as if to show in how little need he stood of preparation,

or how lightly he held his adversaries, he spent the six weeks that elapsed between the challenge and the contest, in a continual round of tilting, hunting, and dancing.

On the appointed day, however, and in the contest, he is said to have encountered all the gravest philosophers and divines, and to have acquitted himself to the astonishment of all who heard him. He received the public praises of the president and four of the most eminent professors. The very next day he appeared at a tilting match in the Louvre, and carried off the ring from all his accomplished and experienced competitors.

Enthusiasm was now at its height, particularly among the ladies of the court, and from the versatility of his talents, his youth, the gracefulness of his manners, and the beauty of his person, he was named *L'Admirable*. After serving two years in the army of Henry III., who was engaged in a civil war with his Huguenot subjects, Crichton repaired to Italy, and repeated at Rome, in the presence of the Pope and cardinals, the literary challenge and triumph that had gained him so much honor at Paris.

From Rome he went to Venice, at which gay city he arrived in a depressed state of spirits. None of his Scottish biographers are very willing to acknowledge the fact, but it appears quite certain, that, spite of his noble birth and connexions, he was miserably poor, and became for some time dependent on the bounty of a Venetian printer—the celebrated Aldus Manutius. After a residence of four months at Venice, where his learning, engaging manners, and various

accomplishments, excited universal wonder, as is made evident by several Italian writers who were living at the time, and whose lives were published, Crichton went to the neighboring city of Padua, in the learned university of which he reaped fresh honors by Latin poetry, scholastic disputation, an exposition of the errors of Aristotle and his commentators, and as a playful wind-up of the day's labors, a declamation upon the happiness of ignorance.

Another day was fixed for a public disputation in the palace of the bishop of Padua; but this being prevented from taking place, gave some incredulous or envious men the opportunity of asserting that Crichton was a literary impostor, whose acquirements were totally superficial. His reply was a public challenge. The contest, which included the Aristotelian and platonic philosophies, and the mathematics of the time, was prolonged during three days, before an innumerable concourse of people. His friend, Aldus Manutius, who was present at what he calls "this miraculous encounter," says he proved completely victorious, and that he was honored by such a rapture of applause as was never before heard.

Crichton's journeying from university to university to stick up challenges on church doors, and college pillars, though it is said to have been in accordance with customs not then obsolete, certainly attracted some ridicule among the Italians; for Boccalini, after copying one of his placards, in which he announces his arrival, and his readiness to dispute extemporaneously on all subjects, says that a wit wrote under it, "and whosoever wishes to see him, let him go to

the Falcon Inn, where he will be shown,"—which is the formula used by showmen for the exhibition of a wild beast, or any other monster.

We next hear of Crichton at Mantua, and as the hero of a combat more tragical than those carried on by the tongue or the pen. A certain Italian gentleman, "of a mighty, able, nimble, and vigorous body, but by nature fierce, cruel, warlike, and audacious, and superlatively expert and dexterous in the use of his weapon," was in the habit of going from one city to another, to challenge men to fight with cold steel, just as Crichton did to challenge them to scholastic combats. This itinerant gladiator, who had marked his way through Italy with blood, had just arrived in Mantau, and killed three young men, the best swordsmen of that city. By universal consent, the Italians were the ablest masters of fence in Europe; a reputation to which they seem still entitled. To encounter a victor among such masters, was a stretch of courage; but Crichton, who had studied the sword from his youth, and who had probably improved himself in the use of the rapier in Italy, did not hesitate to challenge the redoubtable bravo.

Though the duke was unwilling to expose so accomplished a gentleman to so great a hazard, yet, relying upon the report he had heard of his warlike qualifications, he agreed to the proposal; and the time and place being appointed, the whole court attended to behold the performance. At the beginning of the combat, Crichton stood only upon his defence, while the Italian made his attack with such eagerness and fury, that, having exhausted himself, he began to grow

weary. The young Scotsman now seized the opportunity of attacking his antagonist in return; which he did with so much dexterity and vigor, that he ran him through the body in three different places, of which wounds he immediately died.

The acclamations of the spectators were loud and long-continued upon this occasion; and it was acknowledged by all, that they had never seen nature second the precepts of art in so lively and graceful a manner as they had beheld it on that day. To crown the glory of the action, Crichton bestowed the rich prize awarded for his victory, upon the widows of the three persons who had lost their lives in fighting with the gladiator.

In consequence of this and his other wonderful performances, the duke of Mantua made choice of him for preceptor to his son, Vicentio de Gonzago, who is represented as being of a riotous temper, and dissolute life. The appointment was highly pleasing to the court. Crichton, to testify his gratitude to his friends and benefactors, and to contribute to their diversion, framed a comedy, wherein he exposed and ridiculed the weaknesses and failures of the several occupations and pursuits in which men are engaged. This composition was regarded as one of the most ingenious satires that ever was made upon mankind. But the most astonishing part of the story, is, that Crichton sustained fifteen characters in the representation of his own play. Among the rest, he acted the divine, the philosopher, the lawyer, the mathematician, the physician, and the soldier, with such inimitable skill, that every time he appeared upon the theatre, he *seemed to* be a different person.

From being the principal actor in a comedy, Crichton soon became the subject of a dreadful tragedy. One night, during the time of Carnival, as he was walking along the streets of Mantua, and playing upon his guitar, he was attacked by half a dozen people in masks. The assailants found that they had no ordinary person to deal with, for they were not able to maintain their ground against him. At last the leader of the company, being disarmed, pulled off his mask, and begged his life, telling Crichton that he was the prince, his pupil. Crichton immediately fell upon his knees, and expressed his concern for his mistake; alleging that what he had done was only in his own defence, and that if Gonzago had any design upon his life, he might always be master of it. Then, taking his own sword by the point, he presented it to the prince, who immediately received it, and was so irritated by the affront which he thought he had sustained, in being foiled with all his attendants, that he instantly ran Crichton through the heart.

His tragical end excited very great and general lamentation. The whole court of Mantua went three-quarters of a year into mourning for him; and numerous epitaphs and elegies were composed upon his death.

To account in some manner for the extent of Crichton's attainments, it must be recollected that the first scholars of the age were his instructors: for, besides having Rutherford as a tutor, it is stated by Aldus Manutius, that he was also taught by Buchanan, Hessburn, and Robertson; and hence his extraordinary proficiency in the languages, as well as in the sci-

ences, as then taught in the schools of Europe. It must also be recollected that no expense would be spared in his education, as his father was Lord Advocate in Queen Mary's reign, from 1561 to 1573, and his mother, the daughter of Sir James Stuart, was allied to the royal family. It is evident, however, that these advantages were seconded by powers of body and mind rarely united in any human being.

BERONICIUS.

The history of this man is involved in some obscurity, yet enough is known to show that he was a person of wonderful endowments, and great eccentricity of life and character.

In the year 1674, the celebrated Dutch poet, Antonides Vander Goes, being in Zealand, happened to be in company with a young gentleman, who spoke of the wonderful genius of his language master. Vander Goes expressed a desire to see him, and while they were talking upon the subject, the extraordinary man entered. He was a little, sallow dumpling of a fellow, with fiery eyes, and nimble, fidgety motions; he was withal a sight to see for the raggedness of his garments.

The strange man soon showed that he was drunk, and shortly after took his leave. But in a subsequent interview with the Dutch poet, he fully justified the character his pupil had given him. His great talent lay in being able with almost miraculous quickness, to turn any written theme into Latin or Greek verse. Upon being put to the trial, by Vander Goes, he succeeded, to the admiration of all present.

The poet had just shown him his verses, and asked his opinion of them. Beronicius read them twice, praised them, and said, " What should hinder me from

turning them into Latin instantly?" The company viewed him with curiosity, and encouraged him by saying, "Well, pray let us see what you can do." In the meantime, the man appeared to be startled. He trembled from head to foot, as if possessed. However, he selected an epigram from the poems, and asked the precise meaning of two or three Dutch words, of which he did not clearly understand the force, and requested that he might be allowed to Latinize the name of *Hare*, which occurred in the poem, in some manner so as not to lose the pun. They agreed; and he immediately said, "I have already found it,—I shall call him *Dasypus*," which signifies an animal with rough legs, and is likewise taken by the Greeks for a hare. "Now, read a couple of lines at a time to me, and I shall give them in Latin," said he;—upon which a poet named Buizero, began to read to him, and Beronicius burst out in the following verses:—

Egregia Dasypus referens virtute leonem
In bello, adversus Britonas super æquora gesto,
Impavidus pelago stetit, aggrediente molossum.
Agmine quem tandem glans ferrea misit ad astra,
Vindictæ cupidum violato jure profundi.
Advena, quisquis ades, Zelandæ encomia gentis
Ista refer, lepores demta quod pelle leonem,
Assumant, quotquot nostro versantur in orbe.
Epitaphium Herois Adriani de Haze, ex Belgico versum.

When the poet had finished, he laughed till his sides shook; at the same time he was jeering and pointing at the company, who appeared surprised at his having, contrary to their expectations, acquitted himself so well; everybody highly praised him, which elated him so much that he scratched his head three or four

times; and fixing his fiery eyes on the ground, repeated without hesitation, the same epigram in Greek verse, calling out, "There ye have it in Greek." Every one was astonished, which set him a-laughing and jeering for a quarter of an hour.

The Greek he repeated so rapidly, that no one could write from his recitation. John Frederick Gymnick, professor of the Greek language at Duisburgh, who was one of the auditors, said that he esteemed the Greek version as superior to the Latin. Beronicius was afterwards examined in various ways, and gave such proofs of his wonderful learning, as amazed all the audience.

This singular genius spoke several languages so perfectly, that each might have passed for his mother tongue; especially Italian, French, and English. But Greek was his favorite, and he used it as correctly and as fluently as if he had always spoken it. He knew by heart the whole of Horace and Virgil, the greatest part of Cicero, and both the Plinys; and would immediately, if a line were mentioned, repeat the whole passage, and tell the exact work, volume, chapter, and verse, of all these, and many more, especially poets. The works of Juvenal were so interwoven with his brain, that he retained every word.

Of the Greek poets, he had Homer strongly imprinted on his memory, together with some of the comedies of Aristophanes; he could directly turn to any line required, and repeat the whole contiguous passage. His Latin was full of words selected from the most celebrated writers.

The reader will probably be desirous of knowing

to what country Beronicius belonged; but this is a secret he never would disclose. When he was asked what was his native land, he always answered, "that the country of every one, was that in which he could live most comfortably." It was well known that he had wandered about many years in France, England, and the Netherlands, carrying his whole property with him. He was sometimes told that he deserved to be a professor in a college;—but his reply was, that he could have no pleasure in such a worm-like life.

Strange to say, this eccentric being gained his living chiefly by sweeping chimneys, grinding knives and scissors, and other mean occupations. But his chief delight was in pursuing the profession of a juggler, mountebank, or merry-andrew, among the lowest rabble. He never gave himself any concern about his food or raiment; for it was equal to him whether he was dressed like a nobleman or a beggar. His hours of relaxation from his studies were chiefly spent in paltry wine-houses, with the meanest company, where he would sometimes remain a whole week, or more, drinking without rest or intermission.

His miserable death afforded reason to believe that he perished whilst intoxicated, for he was found dead at Middleburgh, drowned and smothered in mud, which circumstance is alluded to in the epitaph which the before named poet, Buizero, wrote upon him, and which was as follows:—

Here lies a wonderful genius,
He lived and died like a beast;
He was a most uncommon satyr—
He lived in wine, and died in water

This is all that is known of Beronicius. The poet, Vander Goes, often witnessed the display of his talents, and he says that he could at once render the newspapers into Greek and Latin verse. Professor John de Raay, who was living at the time of Beronicius's death, which occurred in 1676, saw and affirms the same wonderful fact.

MASTER CLENCH.

Of this astonishing youth, we have no information except what is furnished by the following account, extracted from Mr. Evelyn's diary, of 1689, very shortly after the landing of William III. in England.

"I dined," says Mr. Evelyn, "at the Admiralty, where a child of twelve years old was brought in, the son of Dr. Clench, of the most prodigious maturity of knowledge, for I cannot call it altogether memory, but something more extraordinary. Mr. Pepys and myself examined him, not in any method, but with promiscuous questions, which required judgment and discernment, to answer so readily and pertinently.

"There was not anything in chronology, history, geography, the several systems of astronomy, courses of the stars, longitude, latitude, doctrine of the spheres, courses and sources of rivers, creeks, harbors, eminent cities, boundaries of countries, not only in Europe, but in every part of the earth, which he did not readily resolve, and demonstrate his knowledge of, readily drawing with a pen anything he would describe.

"He was able not only to repeat the most famous things which are left us in any of the Greek or Roman histories, monarchies, republics, wars, colonies, exploits by sea and land, but all the Sacred Scriptures of the Old and New Testaments; the succession of all the

monarchies, Babylonian, Persian, Greek and Roman; with all the lower emperors, popes, heresiarchs, and councils; what they were called about; what they determined; or in the controversy about Easter; the tenets of the Sabellians, Arians, Nestorians; and the difference between St. Cyprian and Stephen about re-baptization; the schisms.

"We leaped from that to other things totally different,—to Olympic years and synchronisms; we asked him questions which could not be answered without considerable meditation and judgment; nay, of some particulars of the civil wars; of the digest and code. He gave a stupendous account of both natural and moral philosophy, and even of metaphysics.

"Having thus exhausted ourselves, rather than this wonderful child, or angel rather, for he was as beautiful and lovely in countenance as in knowledge, we concluded with asking him, if, in all he had ever heard or read of, he had ever met with anything which was like the expedition of the Prince of Orange, with so small a force, as to obtain three kingdoms without any contest. After a little thought, he told us that he knew of nothing that resembled it, so much as the coming of Constantine the Great out of Great Britain, through France and Italy, so tedious a march, to meet Maxentius, whom he overthrew at Pons Melvius, with very little conflict, and at the very gates of Rome, which he entered, and was received with triumph, and obtained the empire not of three kingdoms only, but of the then known world.

"He was perfect in the Latin authors, spoke French naturally, and gave us a description of France, Italy,

Savoy and Spain, anciently and modernly divided; as also of ancient Greece, Scythia, and the northern countries and tracts.

"He answered our questions without any set or formal repetitions, as one who had learned things without book, but as if he minded other things, going about the room, and toying with a parrot, seeming to be full of play, of a lively, sprightly temper, always smiling, and exceedingly pleasant; without the least levity, rudeness, or childishness."

JEDEDIAH BUXTON.

THIS extraordinary man was born in 1705, at Elmeton, in Derbyshire. His father was a schoolmaster; and yet, from some strange neglect, Jedediah was never taught either to read or write. So great, however, were his natural talents for calculation, that he became remarkable for his knowledge of the relative proportions of numbers, their powers and progressive denominations. To these objects he applied all the powers of his mind, and his attention was so constantly rivetted upon them, that he was often totally abstracted from external objects. Even when he did notice them, it was only with respect to their numbers. If any space of time happened to be mentioned before him, he would presently inform the company

that it contained so many minutes; and if any distance, he would assign the number of hair-breadths in it, even though no question were asked him.

Being, on one occasion, required to multiply 456 by 378, he gave the product by mental arithmetic, as soon as a person in company had completed it in the common way. Being requested to work it audibly, that his method might be known, he first multiplied 456 by 5, which produced 2,280; this he again multiplied by 20, and found the product 45,600, which was the multiplicand, multiplied by 100. This product he again multiplied by 3, which gave 136,800, the product of the multiplicand by 300. It remained, therefore, to multiply this by 78, which he effected by multiplying 2,280, or the product of the multiplicand, multiplied by 5, by 15, as 5 times 15 is 75. This product being 34,200, he added to 136,800, which gave 171,000, being the amount of 375 times 456. To complete his operation, therefore, he multiplied 456 by 3, which produced 1,368, and this being added to 171,000, yielded 172,368, as the product of 456 multiplied by 378.

From these particulars, it appears that Jedediah's method of calculation was entirely his own, and that he was so little acquainted with the common rules of arithmetic, as to multiply first by 5, and the product by 20, to find the amount when multiplied by 100, which the addition of two ciphers to the multiplicand would have given at once.

A person who had heard of these efforts of memory, once meeting with him accidentally, proposed the following question, in order to try his calculating

powers. If a field be 423 yards long, and 383 broad, what is the area? After the figures were read to him distinctly, he gave the true product, 162,009 yards, in the space of two minutes; for the proposer observed by the watch, how long it took him. The same person asked how many acres the said field measured; and in eleven minutes, he replied, 33 acres, 1 rood, 35 perches, 20 yards and a quarter. He was then asked how many barley-corns would reach eight miles. In a minute and a half, he answered 1,520,-640. The next question was: supposing the distance between London and York to be 204 miles, how many times will a coach-wheel turn round in that space, allowing the circumference of that wheel to be six yards. In thirteen minutes, he answered, 59,840 times.

On another occasion a person proposed to him this question: in a body, the three sides of which are 23,-145,789 yards, 5,642,732 yards, and 54,965 yards, how many cubic eighths of an inch? In about five hours Jedediah had accurately solved this intricate problem, though in the midst of business, and surrounded by more than a hundred laborers.

Next to figures, the only objects of Jedediah's curiosity were the king and royal family. So strong was his desire to see them, that in the beginning of the spring of 1754, he walked up to London for that purpose, but returned disappointed, as his majesty had removed to Kensington just as he arrived in town. He was, however, introduced to the Royal Society, whom he called the *Folk of the Siety Court.* The gentlemen present asked him several questions

in arithmetic to try his abilities, and dismissed him with a handsome present.

During his residence in the metropolis, he was taken to see the tragedy of King Richard the Third, performed at Drury Lane, Garrick being one of the actors. It was expected that the novelty of everything in that place, together with the splendor of the surrounding objects, would have filled him with astonishment; or that his passions would have been roused in some degree, by the action of the performers, even though he might not fully comprehend the dialogue. This, certainly, was a rational idea; but his thoughts were far otherwise employed. During the dances, his attention was engaged in reckoning the number of steps; after a fine piece of music, he declared that the innumerable sounds produced by the instruments perplexed him beyond measure, but he counted the words uttered by Mr. Garrick, in the whole course of the entertainment; and declared that in this part of the business, he had perfectly succeeded.

Heir to no fortune, and educated to no particular profession, Jedediah Buxton supported himself by the labor of his hands. His talents, had they been properly cultivated, might have qualified him for acting a distinguished part on the theatre of life; he, nevertheless, pursued the "noiseless tenor of his way," content if he could satisfy the wants of nature, and procure a daily subsistence for himself and family. He was married and had several children. He died in the year 1775, aged seventy years. Though a man of wonderful powers of arithmetical calculation,

and generally regarded as a prodigy in his way—it is still obvious that, after the practice of years, he was incapable of solving questions, which Zerah Colburn, at the age of six or seven years, answered in the space of a few seconds.

WILLIAM GIBSON.

William Gibson was born in the year 1720, at the village of Bolton, in Westmoreland, England. On the death of his father, he put himself to a farmer to learn his business. When he was about eighteen or nineteen, he rented a small farm of his own, at a place called Hollins, where he applied himself assiduously to study.

A short time previous to this, he had admired the operation of figures, but labored under every disadvantage, for want of education. As he had not yet been taught to read, he got a few lessons in English, and was soon enabled to comprehend a plain author. He then purchased a treatise on arithmetic; and though he could not write, he soon became so expert a calculator, from mental operations only, that he could tell, without setting down a figure, the product of any two numbers multiplied together, although the multiplier and the multiplicand each of them consisted of nine figures. It was equally astonishing that he could answer, in the same manner, questions in division, in decimal fractions, or in the extraction of the square or cube roots, where such a multiplicity

of figures is often required in the operation. Yet at this time he did not know that any merit was due to himself, conceiving that the capacity of other people was like his own.

Finding himself still laboring under farther difficulties for want of a knowledge of writing, he taught himself to write a tolerable hand. As he had not heard of mathematics, he had no idea of anything, in regard to numbers, beyond what he had learned. He thought himself a master of figures, and challenged all his companions and the members of a society he attended, to a trial. Something, however, was proposed to him concerning Euclid. As he did not understand the meaning of the word, he was silent; but afterwards found it meant a book, containing the elements of geometry; this he purchased, and applied himself very diligently to the study of it, and against the next meeting he was prepared with an answer in this new science.

He now found himself launching out into a field, of which before he had no conception. He continued his geometrical studies; and as the demonstration of the different propositions in Euclid depend entirely upon a recollection of some of those preceding, his memory was of the utmost service to him. Besides, it was a study exactly adapted to his mind; and while he was attending to the business of his farm, and humming over some tune or other, his attention was often engaged with some of his geometrical propositions. A few figures with a piece of chalk, upon the knee of his breeches, or any other convenient spot, were all

he needed to clear up the most difficult parts of the science.

He now began to be struck with the works of nature, and paid particular attention to the theory of the earth, the moon, and the rest of the planets belonging to this system, of which the sun is the centre; and considering the distance and magnitude of the different bodies bolonging to it, and the distance of the fixed stars, he soon conceived each of them to be the centre of a different system. He well considered the law of gravity, and that of the centripetal and centrifugal forces, and the cause of the ebbing and flowing of the tides; also the projection of the sphere—stereographic, orthographic, and gnomical; also trigonometry and astronomy. By this time he was possessed of a small library.

He next turned his thoughts to algebra, and took up Emerson's treatise on that subject, and went through it with great success. He also grounded himself in the art of navigation and the principles of mechanics; likewise the doctrine of motion, of falling bodies, and the elements of optics, &c., as a preliminary to fluxions, which had but lately been discovered by Sir Isaac Newton; as the boundary of the mathematics, he went through conic sections, &c. Though he experienced some difficulty at his first entrance, yet he did not rest till he made himself master of both a fluxion and a flowing quantity. As he had paid a similar attention to the intermediate parts, he soon became so conversant with every branch of the mathematics, that no question was ever proposed to him which he could not answer.

He used to take pleasure in solving the arithmetical questions then common in the magazines, but his answers were seldom inserted, except by or in the name of some other person, for he had no ambition to make his abilities known. He frequently had questions from his pupils and other gentlemen in London; from the universities of Oxford and Cambridge, and different parts of the country, as well as from the university of Gottingen in Germany. These, however difficult, he never failed to answer; and from the minute inquiry he made into natural philosophy, there was scarcely a phenomenon in nature, that ever came to his knowledge or observation, but he could, in some measure at least, reasonably account for it.

He went by the name of Willy-o'-th'-Hollins, for many years after he left his residence in that place. The latter portion of his life was spent in the neighborhood of Cartmell, where he was best known by the name of Willy Gibson, still continuing his former occupation. For the last forty years he kept a school of about eight or ten gentlemen, who boarded and lodged at his own farm-house; and having a happy turn in explaining his ideas, he formed a great number of very able mathematicians, as well as expert accountants. This self-taught philosopher and wonderful man, died on the 4th of October, 1792, at Blaith, near Cartmell, in consequence of a fall, leaving behind him a widow and ten children.

EDMUND STONE.

Of the life of this extraordinary man we have little information. He was probably born in Argyleshire, Scotland, at the close of the seventeenth century. His father was gardener to the Duke of Argyle, and the son assisted him. The duke was walking one day in his garden, when he observed a Latin copy of Newton's Principia, lying on the grass, and supposing it had been brought from his own library, called some one to carry it back to its place. Upon this, young Stone, who was in his eighteenth year, claimed the book as his own. "Yours!" replied the duke; "do you understand geometry, Latin, and Newton?" "I know a little of them," said the young man.

The duke was surprised, and having a taste for the sciences, he entered into conversation with the young mathematician. He proposed several inquiries, and was astonished at the force, the accuracy and the clearness of his answers. "But how," said the duke, "came you by the knowledge of all these things?" Stone replied, "A servant taught me to read ten years since. Does one need to know anything more than the twenty-six letters, in order to learn everything else that one wishes?"

The duke's curiosity was now greatly increased, and he sat down upon a bank and requested a detail of the whole process by which he had acquired such knowledge. "I first learned to read," said Stone; "afterwards, when the masons were at work at your house, I approached them one day, and observed that the architect used a rule and compass, and that he made calculations. I inquired what might be the meaning and use of these things; and I was informed that there was a science called arithmetic. I purchased a book of arithmetic, and studied it. I was told that there was another science, called geometry. I bought the necessary books, and learned geometry.

"By reading, I found there were good books on these two sciences in Latin; I therefore bought a dictionary and learned Latin. I understood, also, that there were good books of the same kind in French; I bought a dictionary and learned French; and this, my lord, is what I have done. It seems to me that we may learn everything when we know the twenty-six letters of the alphabet."

Under the duke's patronage, Stone rose to be a very considerable mathematician, and was elected a member of the Royal Society of London, in 1725. He seems to have lost the favor of the Duke of Argyle, for, in the latter part of his life, he gave lessons in mathematics, and at last died in poverty.

RICHARD EVELYN.

JOHN EVELYN, a very learned English writer, was born in 1620, and died in 1706. He published several works, all of which are valuable. His treatises upon Natural History are greatly valued. He kept a diary, which has been published, and which contains much that is interesting. Of one of his children, who died early, he gives us the following account:

"After six fits of ague, died, in the year 1658, my son Richard, five years and three days old, but, at that tender age, a prodigy of wit and understanding; for beauty of body, a very angel; for endowment of mind, of incredible and rare hopes. To give only a little taste of some of them, and thereby glory to God:

"At two years and a half old, he could perfectly read any of the English, Latin, French, or Gothic letters, pronouncing the three first languages exactly. He had, before the fifth year, not only skill to read most written hands, but to decline all the nouns, conjugate the verbs regular and most of the irregular; learned Pericles through; got by heart almost the entire vocabulary of Latin and French primitives and

words, could make congruous syntax, turn English into Latin, and *vice versâ*, construe and prove what he read, and did the government and use of relative verbs, substantives, ellipses, and many figures and tropes, and made a considerable progress in Comenius's Janua; began himself to write legibly, and had a strong passion for Greek.

"The number of verses he could recite was enormous; and when seeing a Plautus in one's hand, he asked what book it was, and being told it was comedy and too difficult for him, he wept for sorrow. Strange was his apt and ingenious application of fables and morals, for he had read Æsop. He had a wonderful disposition to mathematics, having by heart divers propositions of Euclid, that were read to him in play, and he would make lines and demonstrate them.

"As to his piety, astonishing were his applications of Scripture upon occasion, and his sense of God: he had learned all his catechism early, and understood the historical part of the Bible and Testament to a wonder—how Christ came to mankind; and how, comprehending these necessaries himself, his godfathers were discharged of their promise. These and like illuminations, far exceeding his age and experience, considering the prettiness of his address and behavior, cannot but leave impressions in me at the memory of him. When one told him how many days a Quaker had fasted, he replied, that was no wonder, for Christ had said 'man should not live by bread alone, but by the word of God.'

"He would, of himself, select the most pathetic Psalms, and chapters out of Job, to read to his maid

during his sickness, telling her, when she pitied him, that all God's children must suffer affliction. He declaimed against the vanities of the world, before he had seen any. Often he would desire those who came to see him, to pray by him, and a year before he fell sick, to kneel and pray with him, alone in some corner. How thankfully would he receive admonition! how soon be reconciled! how indifferent, yet continually cheerful! He would give grave advice to his brother John, bear with his impertinences, and say he was but a child.

"If he heard of, or saw any new thing, he was unquiet till he was told how it was made; he brought to us all such difficulties as he found in books, to be expounded. He had learned by heart divers sentences in Greek and Latin, which on occasions he would produce even to wonder. He was all life, all prettiness, far from morose, sullen, or childish in anything he said or did. The last time he had been at church, which was at Greenwich, I asked him, according to custom, what he remembered of the sermon. 'Two good things, father,' said he, '*bonum gratiæ*, and *bonum gloriæ;*' the excellence of grace, and the excellence of glory,—with a just account of what the preacher said.

"The day before he died, he called to me, and, in a more serious manner than usual, told me, that for all I loved him so dearly, I should give my house, land, and all my fine things to his brother Jack,—he should have none of them; and next morning, when he found himself ill, and I persuaded him to keep his hands in bed, he demanded whether he might pray

to God with his hands unjoined; and a little after, whilst in great agony, whether he should not offend God by using his holy name so often by calling for ease.

"What shall I say of his frequent pathetical ejaculations uttered of himself: 'Sweet Jesus, save me, deliver me, pardon my sins, let thine angels receive me!' So early knowledge, so much piety and perfection! But thus God, having dressed up a saint fit for himself, would no longer permit him with us, unworthy of the future fruits of this incomparable, hopeful blossom. Such a child I never saw! for such a child I bless God, in whose bosom he is! May I and mine become as this little child, which now follows the child Jesus, that lamb of God, in a white robe, whithersoever he goes! Even so, Lord Jesus, let thy will be done. Thou gavest him to us, thou hast taken him from us; blessed be the name of the Lord! That I had anything acceptable to thee was from thy grace alone, since from me he had nothing but sin; but that thou hast pardoned, blessed be my God forever! Amen."

QUENTIN MATSYS.

This great painter was born at Antwerp, in 1460, and followed the trade of a blacksmith and farrier, till he approached manhood. His health at that time was feeble, and rendered him unfit for so laborious a pursuit; he therefore undertook to execute lighter work. He constructed an iron railing around a well near the great church of Antwerp, which was greatly admired for its delicacy and the devices with which it was ornamented. He also executed an iron balustrade for the college of Louvain, which displayed extraordinary taste and skill.

His father had died, when he was young, leaving him and his mother entirely destitute. Notwithstanding his feeble constitution, he was obliged to support both himself and her. While necessity thus urged him, his taste guided his efforts toward works of art. At Louvain there was an annual procession of lepers, who were accustomed to distribute little images of saints upon that occasion. Matsys devoted himself to the making of these, in which he was very successful.

The Misers.

He had now reached the age of twenty, when it appears that he fell in love with the daughter of a painter, of some cleverness, in Antwerp. His affection was returned, but when he applied to the father to obtain his consent to their union, he was answered by a flat refusal, and the declaration, that no man but a painter, as good as himself, should wed his daughter. Matsys endeavored in vain to overcome this resolution, and finally, despairing of other means to accomplish the object which now engrossed his whole soul, he determined to become a painter. The difficulties in his way vanished before that confidence which genius inspires, and taking advantage of his leisure hours, he began to instruct himself secretly in the art of painting. His progress was rapid, and the time of his triumph speedily approached.

He was one day on a visit to his mistress, where he found a picture on the easel of her father, and nearly finished. The old man was absent, and Quentin, seizing the pencil, painted a bee upon a flower in the foreground of the painting, and departed. The artist soon returned, and in sitting down to his picture, immediately discovered the insect, which had so strangely intruded itself upon his canvass. It was so life-like as to make it seem a real insect, that had been deceived by the mimic flower, and had just alighted upon it. The artist was in raptures, for it appears that he had a heart to appreciate excellence, even if it was not his own. He inquired of his daughter who had painted the bee. Though the details of the interview which followed are not

handed down to us, we may be permitted to fill up the scene.

Father. Tell me, child, who painted the insect?

Daughter. Who painted the insect? Really, how should I know?

F. You ought to know,—you must know. It was not one of my pupils. It is beyond them all.

D. Is it as good as you could have done yourself, father?

F. Yes; I never painted anything better in my life. It is like nature's own work, it is so light, so true; on my soul, I was deceived at first, and was about to brush the insect away with my handkerchief.

D. And so, father, you think it is as well as you could have done yourself?

F. Yes.

D. Well, I will send for Quentin Matsys; perhaps he can tell you who did it.

F. Aye, girl, is that it? Did Quentin do it? Then he is a clever fellow, and shall marry you.

Whether such a dialogue as this actually took place, we cannot say; but it appears that Quentin's acknowledged excellence as an artist soon won the painter's consent, and he married the daughter. From this time he devoted his life to the art which love alone had at first induced him to pursue. He soon rose to the highest rank in his profession, and has left behind him an enduring fame. Though he was destitute of early education, and never had the advantage of studying the great masters of the Italian school, he rivalled, in some respects, even their best

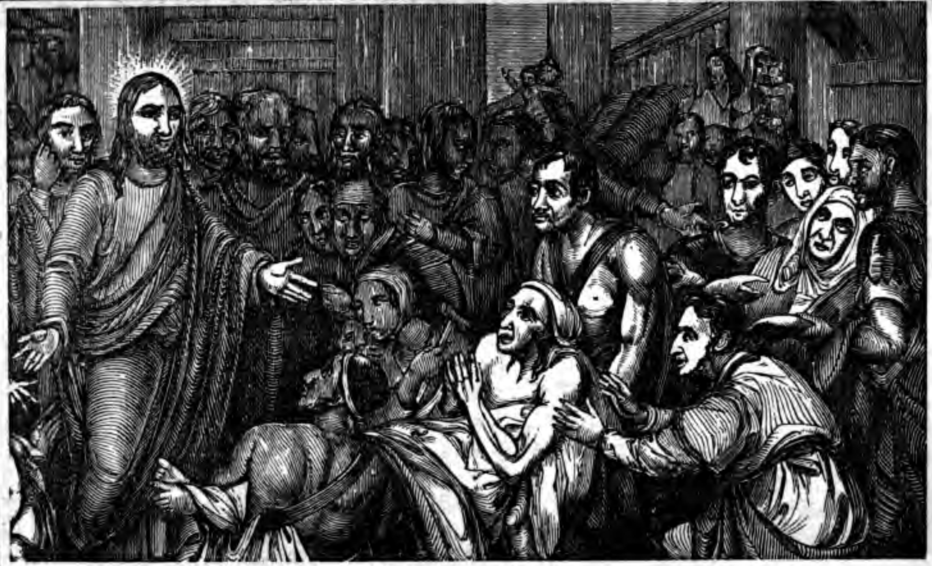
productions. His designs were correct and true to nature, and his coloring was forcible. His pictures are now scarce and command great prices. One of them, called the Two Misers, is in the Royal Gallery of Windsor, England, and is greatly admired. The annexed cut will give some idea of this performance. He died at Antwerp, in 1529.

WEST.

BENJAMIN WEST was born at Springfield, Pennsylvania, October 10, 1738. His father was a merchant, and Benjamin was the tenth child. The first six years of his life passed away in calm uniformity, leaving only the placid remembrance of enjoyment. In the month of June, 1745, one of his sisters who was married, came with her infant daughter to spend a few days at her father's. When the child was asleep in her cradle, Mrs. West invited her daughter to gather flowers in the garden, and committed the infant to the care of Benjamin, during their absence; giving him a fan to drive away the flies from molesting his little charge.

After some time, the child happened to smile in its sleep, and its beauty attracted the boy's attention. He looked at it with a pleasure, which he never before experienced; and observing some paper on a table, together with pens, and red and black ink, he seized them with agitation, and endeavored to delineate a portrait, although at this period, he was only in the seventh year of his age.

Hearing the approach of his mother and sister, he



Christ healing the sick.

endeavored to conceal what he had been doing; but the old lady observing his confusion, inquired what he was about, and requested him to show her the paper. He obeyed, entreating her not to be angry. Mrs. West, after looking at the drawing with evident pleasure, said to her daughter, "I declare, he has made a likeness of little Sally;" she kissed him with much fondness and satisfaction. This encouraged him to say that if it would give her any pleasure, he would make pictures of the flowers which she held in her hand; for the instinct of his genius was now awakened, and he felt that he could imitate the forms of those things which pleased his sight.

Some time after this, Benjamin having heard that pencils for painting were made in Europe of camel's hair, determined to manufacture a substitute, for his own use: accordingly, seizing upon a black cat, kept in the family, he extracted the requisite hairs from her tail for his first brush, and afterwards pillaged it again for others.

Such was the commencement of a series of efforts which raised West to be a favorite painter in England, and, at last, president of the Royal Academy of London. His parents were Quakers, but they encouraged his efforts. He, however, had no advantages, and for some time he was obliged to pursue his labors with such pencils as he made himself, and with red and yellow colors, which he learned to prepare from some Indians who roamed about the town of Springfield: to these, his mother added a little indigo.

He had a cousin by the name of Pennington, who

was a merchant, and having seen some of his sketches, sent him a box of paints and pencils, with canvass prepared, and six engravings. The possession of this treasure almost prevented West's sleeping. He now went into a garret as soon as it was light, and began his work. He was so wrapt up in his task, as to stay from school. This he continued till his master called to inquire what had become of him. A search was consequently made, and he was found at his easel, in the garret. His mother's anger soon subsided, when she saw his picture, now nearly finished. He had not servilely copied one of the engravings, as might have been expected, but had formed a new picture by combining the parts of several of them. His mother kissed the boy with rapture, and procured the pardon of his father and teacher. Mr. Galt, who wrote West's life, says, that, sixty-seven years after, he had the pleasure of seeing this very piece, hanging by the side of the sublime picture of Christ Rejected.

Young West's fame was soon spread abroad, and he was shortly crowded with applications for portraits, of which he painted a considerable number. He was now of an age to require a decision of his parents in respect to the profession he was to follow, in life. They deliberated long and anxiously upon this subject, and at last concluded to refer the matter to the society of Quakers to which they belonged. These decided, that, although they did not acknowledge the utility of painting to mankind, yet they would allow the youth to follow a path for which he had so evident a genius.

At the age of eighteen, he established himself in

Philadelphia, as a portrait painter, and afterwards spent some time at New York, in the same capacity. In both places, his success was considerable. In 1760, aided by friends, he proceeded to Italy, to study his art; in 1763, he went to London, where he soon became established for life. The king, George III., was his steadfast friend, and he became painter to his majesty. He was offered a salary of seven hundred pounds a year, by the Marquis of Rockingham, to embellish his mansion at Yorkshire with historical paintings, but this he declined.

On the death of Sir Joshua Reynolds, he was elected president of the Royal Academy, and took his place in March, 1792. In his sixty-fifth year, he painted his great picture of Christ healing the sick, to aid the Quakers of Philadelphia in the erection of a hospital for that city. It was so much admired that he was offered no less than fifteen thousand dollars for this performance. He accepted the offer, as he was not rich, upon condition that he should be allowed to make a copy for the Friends of Philadelphia, for whom he had intended it. This great picture, of which we give an engraving, was long exhibited at Philadelphia, and the profits essentially aided the benevolent object which suggested the picture.

West continued to pursue his profession, and painted several pictures of great size, under the idea that his talent was best suited to such performances. In 1817, his wife, with whom he had long lived in uninterrupted happiness, died, and he followed her in 1820. If his standing, as an artist, is not of the

highest rank, it is still respectable, and his history affords a striking instance of a natural fitness and predilection for a particular pursuit. If we consider the total want of encouragement to painting, in a Quaker family, in a country town in Pennsylvania, more than a century ago, and advert to the spontaneous display of his taste and its persevering cultivation, we shall see that nature seems to have given him an irresistible impulse in the direction of the art to which he devoted his life.

West was tall, firmly built, and of a fair complexion. He always preserved something of the sedate, even and sober manners of the sect to which his parents belonged; in disposition, he was mild, liberal and generous. He seriously impaired his fortune by the aid he rendered to indigent young artists. His works were very numerous, and the exhibition and sale of those in his hands, at the time of his death, yielded a handsome sum to his family. Though his early education was neglected, he supplied the defect by study and observation, and his writings connected with the arts are very creditable to him as a man, a philosopher and an artist.

BERRETINI.

PIETRO BERRETINI was born 1596, at Cortona, in Italy. He is called Pietro Da Cortona, from the place of his birth. Even when a child, he evinced uncommon genius for painting; but he appeared likely to remain in obscurity and ignorance, as the extreme poverty of his situation precluded him from the usual means of improving natural talent. He struggled, however, with his difficulties, and ultimately overcame every obstacle which opposed him.

When twelve years old, he went, alone and on foot, to Florence, the seat of the fine arts, possessed of no money, and, in fact, completely without resources of any kind. Notwithstanding this gloomy aspect of affairs, he did not lose his courage, but still persevered in a resolution he had thus early formed, to become "an eminent painter." Pietro knew of no person to whom he could apply for assistance in Florence, excepting a poor boy from Cortona, who was then a scullion in the kitchen of Cardinal Sachetti. Pietro sought him out; his little countryman welcomed him very kindly, shared with him his humble meal, offered him the half of his little bed as a lodging, and

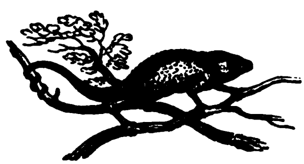
promised to supply him with food from the spare meat of his kitchen.

Thus provided with the necessaries of life, Pietro applied himself with indefatigable diligence to the art to which he had devoted himself, and soon made such progress in it, as, in his own opinion, amply recompensed him for all the toil, privation and difficulties he had undergone. It was interesting to observe this poor, destitute child, without a friend to guide his conduct or direct his studies, devoting himself with such unceasing assiduity to his own improvement. His little friend, the scullion, did not relax in kindness and generosity towards him; for all that he possessed he shared with Pietro, and the latter, in return, brought him all the drawings he made, and with these he adorned the walls of the little garret in which they slept.

Pietro was in the habit of wandering to a distance from Florence, to take views of the beautiful scenery in the environs of that city. When night overtook him unawares, which was often the case, he very contentedly slept under the shelter of a tree, and arose as soon as daylight dawned to renew his employment. During his absence, on one of these excursions, some of his pictures accidentally fell into the hands of Cardinal Sachetti, who, struck with the merit that distinguished them, inquired by what artist they were executed. He was not a little astonished to hear that they were the performances of a poor child, who had, for more than two years, been supported by the bounty of one of his kitchen boys. The cardinal desired to see Pietro; and when the

young artist was brought before him, he received him in a kind manner, assigned him a pension and placed him as a scholar under one of the best painters of Rome.

Pietro afterwards became a very eminent painter, and made the most grateful returns to his friend, the scullion, for the kindness he had shown him in poverty and wretchedness. He spent the latter part of his life at Rome, where he enjoyed the patronage of successive pontiffs, and was made a knight by Pope Alexander III. He was an architect as well as a painter, and designed the church of Saint Martin, at Rome, where he was buried, and to which he bequeathed a hundred thousand crowns. He died 1669, full of wealth and honors. His works display admirable talents, and his history affords a striking example of native genius, overcoming all obstacles, and hewing its way to success in that pursuit for which nature had seemed to create it.



HENRY KIRK WHITE.

This youthful bard, whose premature death was so sincerely regretted by every admirer of genius, was the son of a butcher of Nottingham, England, and born March 21, 1788. He manifested an ardent love of reading in his infancy; this was, indeed, a passion to which everything else gave way. "I could fancy," says his eldest sister, "that I see him in his little chair, with a large book upon his knee, and my mother calling, 'Henry, my love, come to dinner,' which was repeated so often without being regarded, that she was obliged to change the tone of her voice, before she could rouse him."

When he was seven years old, he would creep unperceived into the kitchen, to teach the servant to read and write; and he continued this for some time before it was discovered that he had been thus laudably employed. He wrote a tale of a Swiss emigrant, which was probably his first composition, and gave it to this servant, being ashamed to show it to his mother. "The consciousness of genius," says his biographer, Mr. Southey, "is always, at first, accompanied by this diffidence; it is a sacred, solitary feel-

ing. No forward child, however extraordinary the promise of his childhood, ever produced anything truly great."

When Henry was about eleven years old, he one day wrote a separate theme for every boy in his class, which consisted of about twelve or fourteen. The master said he had never known them write so well upon any subject before, and could not refrain from expressing his astonishment at the excellence of Henry's own composition.

At the age of thirteen, he wrote a poem, "On being confined to school one pleasant morning in spring," from which the following is an extract:

"How gladly would my soul forego
All that arithmeticians know,
Or stiff grammarians quaintly teach,
Or all that industry can reach,
To taste each morn of all the joys
That with the laughing sun arise;
And unconstrained to rove along
The bushy brakes and glens among;
And woo the muse's gentle power
In unfrequented rural bower;
But ah! such heaven-approaching joys
Will never greet my longing eyes;
Still will they cheat in vision fine,
Yet never but in fancy shine."

The parents of Henry were anxious to put him to some trade, and when he was nearly fourteen, he was placed at a stocking loom, with the view, at some future period, of getting a situation in a hosier's warehouse; but the youth did not conceive that nature had intended to doom him to spend seven years of

his life in folding up stockings, and he remonstrated with his friends against the employment. His temper and tone of mind at this period, are displayed in the following extracts from his poems:

——————"Men may rave,
And blame and censure me, that I do n't tie
My ev'ry thought down to the desk, and spend
The morning of my life in adding figures
With accurate monotony; that so
The good things of this world may be my lot,
And I might taste the blessedness of wealth.
But oh! I was not made for money-getting."

* * * * * * *

——————"For as still
I tried to cast, with school dexterity,
The interesting sums, my vagrant thoughts
Would quick revert to many a woodland haunt,
Which fond remembrance cherished; and the pen
Dropt from my senseless fingers, as I pictur'd
In my mind's eye, how on the shores of Trent
I erewhile wander'd with my early friends
In social intercourse."

* * * * * * *

"Yet still, oh contemplation! I do love
T' indulge thy solemn musings; still the same
With thee alone I know how to melt and weep,
In thee alone delighting. Why along
The dusty track of commerce should I toil,
When with an easy competence content,
I can alone be happy, where with thee
I may enjoy the loveliness of nature,
And loose the wings of Fancy? Thus alone
Can I partake of happiness on earth;
And to be happy here is man's chief end,
For, to be happy, he must needs be good."

Young White was soon removed from the loom to the office of a solicitor, which afforded a less obnoxious employment. He became a member of a literary society in Nottingham, and delivered an extempore lecture on genius, in which he displayed so much talent, that he received the unanimous thanks of the society, and they elected him their professor of literature.

At the age of fifteen, he gained a silver medal for a translation from Horace ; and the following year, a pair of globes, for an imaginary tour from London to Edinburgh. He determined upon trying for this prize one evening when at tea with his family, and at supper, he read them his performance. In his seventeenth year, he published a small volume of poems which possessed considerable merit.

Soon after, he was sent to Cambridge, and entered Saint John's College, where he made the most rapid progress. But the intensity of his studies ruined his constitution, and he fell a victim to his ardent thirst for knowledge. He died October 19, 1806, leaving behind him several poems and letters, which gave earnest of the high rank he would have attained in the republic of letters, had his life been spared. His productions were published, with an interesting memoir, by Mr. Southey.

MOZART.

John Chrysostomus Wolfgang Amadeus Mozart, was born at Salzburg, in 1756. His father was an eminent musician, and the early proficiency of his son in music was almost incredible. He began the piano at three years of age; and from this period lost all pleasure in his other amusements. His taste was so scientific that he would spend his time in looking for thirds, and felt charmed with their harmony. At five years old, he began to compose little pieces, of such ingenuity that his father wrote them down.

He was a creature of universal sensibility, a natural enthusiast—from his infancy fond, melancholy and tearful. When scarcely able to walk, his first question to his friends, who took him on their knee, was, whether they loved him; and a negative always made him weep. His mind was all alive; and whatever touched it, made it palpitate throughout. When he was taught the rudiments of arithmetic, the walls and tables of his bed-chamber were found covered with figures. But the piano was the grand object of his devotion.

At six years old, this singular child commenced, with his father, and sister two years older than himself, one of those musical tours common in Germany;

and performed at Munich before the Elector, to the great admiration of the most musical court on the continent. His ear now signalized itself, by detecting the most minute irregularities in the orchestra. But its refinement was almost a disease ; a discord tortured him ; he conceived a horror of the trumpet, except as a single accompaniment, and suffered from it so keenly, that his father, to correct what he regarded as the effect of ignorant terror, one day desired a trumpet to be blown in his apartment. The child entreated him not to make the experiment ; but the trumpet sounded. Young Mozart suddenly turned pale, fell on the floor, and was on the point of going into convulsions, when the trumpeter was sent out of the room.

When only seven years old, he taught himself the violin ; and thus, by the united effort of genius and industry, mastered the most difficult of all instruments. From Munich, he went to Vienna, Paris, and London. His reception in the British metropolis was such as the curious give to novelty, the scientific to intelligence, and the great to what administers to stately pleasure. He was flattered, honored, and rewarded. Handel had then made the organ a favorite, and Mozart took the way of popularity. His execution, which on the piano had astonished the English musicians, was equally wonderful on the organ, and he overcame all rivalry. On his departure from England, he gave a farewell concert, of which all the symphonies were composed by himself. This was the career of a child nine years old.

With the strengthening of his frame, the acuteness of his ear became less painful ; the trumpet had lost

its terror for him at ten years old; and before he had completed that period, he distinguished the church of the Orphans, at Vienna, by the composition of a mass and a trumpet duet, and acted as director of the concert.

Mozart had travelled the chief kingdoms of Europe, and seen all that could be shown to him there, of wealth and grandeur. He had yet to see the empire of musical genius. Italy was an untried land, and he went at once to its capital. He was present at the performance of Handel's admirable chant, the Miserere, which seems then to have been performed with an effect unequalled since. The singers had been forbidden to give a copy of this composition. Mozart bore it away in his memory, and wrote it down. This is still quoted among musicians, as almost a miracle of remembrance; but it may be more truly quoted as an evidence of the power which diligence and determination give to the mind. Mozart was not remarkable for memory; what he did, others may do; but the same triumph is to be purchased only by the same exertion. The impression of this day lasted during Mozart's life; his style was changed; he at once adopted a solemn reverence for Handel, whom he called "The Thunderbolt," and softened the fury of his inspiration, by the taste of Boccherini. He now made a grand advance in his profession, and composed an opera, "Mithridates," which was played twenty nights at Milan.

Mozart's reputation was soon established, and he was liberally patronised by the Austrian court. The following anecdote shows the goodness of his heart,

and the estimation in which he was held. One day, as he was walking in the suburbs of Vienna, he was accosted by a mendicant, of a very prepossessing appearance and manner, who told his tale of wo with such effect, as to interest the musician strongly in his favor; but the state of his purse not corresponding with the impulse of his humanity, he desired the applicant to follow him to a coffee-house. Here Mozart, drawing paper from his pocket, in a few minutes composed a minuet, which, with a letter, he gave to the distressed man, desiring him to take it to his publisher. A composition from Mozart was a bill payable at sight; and to his great surprise, the now happy beggar was immediately presented with five double ducats.

The time which Mozart most willingly employed in compositions, was the morning, from six or seven o'clock till about the hour of ten. After this, he usually did no more for the rest of the day, unless he had to finish some piece that was wanted. He however always worked irregularly. When an idea struck him, he was not to be drawn from it, even if he were in the midst of his friends. He sometimes passed whole nights with his pen in his hand. At other times, he had such a disinclination to work, that he could not complete a piece till the moment of its performance. It once happened, that he put off some music which he had engaged to furnish for a court concert, so long, that he had not time to write out the part he was to perform himself. The Emperor Joseph, who was peeping everywhere, happening to cast his eyes on the sheet which Mozart seemed to be playing from, was surprised to see nothing but empty

lines, and said to him, "Where 's your part?" "Here," said Mozart, putting his hand to his forehead.

The Don Giovanni of this eminent composer, which is one of the most popular compositions ever produced, was composed for the theatre at Prague, and first performed in that city in 1787. This refined and intellectual music was not at that time understood in Germany; a circumstance which Mozart seems to have anticipated, for, previous to its first representation, he remarked to a friend, "This opera is not calculated for the people of Vienna; it will be more justly appreciated at Prague; but in reality I have written it principally to please myself and my friends." Ample justice has however at length been rendered to this great production; it is heard with enthusiasm in nearly all the principal cities of that quarter of the globe where music is cultivated as a science—from the frozen regions of Russia, to the foot of Mount Vesuvius. Its praise is not limited by the common attributes of good musical composition; it is placed in the higher rank of fine poetry; for not only are to be found in it exquisite melodies and profound harmonies, but the playful, the tender, the pathetic, the mysterious, the sublime, and the terrible, are to be distinctly traced in its various parts.

The overture to this opera is generally esteemed Mozart's best effort; yet it was only composed the night previous to the first representation, after the general rehearsal had taken place. About eleven o'clock in the evening, when retired to his apartment, he desired his wife to make him some punch, and to stay with him, in order to keep him awake. She

accordingly began to tell him fairy tales, and odd stories, which made him laugh till the tears came. The punch, however, made him so drowsy, that he could go on only while his wife was talking, and dropped asleep as soon as she ceased. The efforts which he made to keep himself awake, the continual alternation of sleep and watching, so fatigued him, that his wife persuaded him to take some rest, promising to awake him in an hour's time. He slept so profoundly that she suffered him to repose for two hours. At five o'clock in the morning, she awoke him. He had appointed the music copiers to come at seven, and by the time they arrived, the overture was finished. They had scarcely time to write out the copy necessary for the orchestra, and the musicians were obliged to play it without a rehearsal. Some persons pretend, that they can discover in this overture the passages where Mozart dropped asleep and those where he suddenly awoke again.

This great composer was so absorbed in music, that he was a child in every other respect. He was extremely apprehensive of death; and it was only by incessant application to his favorite study, that he prevented his spirits from sinking totally under the fears of approaching dissolution. At all other times he labored under a profound melancholy, during which he composed some of his best pieces, particularly his celebrated Requiem. The circumstances attending this were remarkable.

One day, when his spirits were unusually oppressed, a stranger, of a tall, dignified appearance, was introduced. His manners were grave and impressive.

He told Mozart that he came from a person who did not wish to be known, to request that he would compose a solemn mass, as a requiem for the soul of a friend, whom he had recently lost, and whose memory he was desirous of commemorating by this imposing service. Mozart undertook the task, and engaged to have it completed in a month. The stranger begged to know what price he set upon his work; and immediately paying him one hundred ducats, he departed.

The mystery of this visit seemed to have a strong effect on the mind of the musician. He brooded over it for some time; and then suddenly calling for writing materials, began to compose with extraordinary ardor. This application, however, was more than his strength could support; it brought on fainting fits, and his increasing illness obliged him to suspend his work. "I am writing the requiem for myself," said he one day to his wife; "it will serve for my own funeral service;" and this impression never afterwards left him. At the expiration of the month, the mysterious stranger appeared, and demanded the requiem. "I have found it impossible," said Mozart, "to keep my word; the work has interested me more than I expected, and I have extended it beyond my first design. I shall require another month to finish it."

The stranger made no objection; but observing that for this additional trouble it was but just to increase the premium, laid down fifty ducats more, and promised to return at the time appointed. Astonished at his whole proceeding, Mozart ordered a servant to follow this singular personage, and, if possible, to find out who he was. The man, however, lost sight of

him, and was obliged to return as he went. Mozart, now more than ever persuaded that he was a messenger from the other world, sent to warn him that his end was approaching, applied with fresh zeal to the requiem; and in spite of his exhausted state, both of body and mind, he completed it before the end of the month. At the appointed day, the stranger returned; the requiem was finished; but Mozart was no more! He died at Vienna, 1791, aged 35 years.

ELIHU BURRITT.

In an address delivered by Governor Everett, before a Mechanics' Association, in Boston, 1837, he introduced a letter from Elihu Burritt, a native of Connecticut, and then a resident of Worcester, Massachusetts, of which the following is a copy:—

"I was the youngest of many brethren, and my parents were poor. My means of education were limited to the advantages of a district school, and those again were circumscribed by my father's death, which deprived me, at the age of fifteen, of those scanty opportunities which I had previously enjoyed.

"A few months after his decease, I apprenticed myself to a blacksmith in my native village. Thither I carried an indomitable taste for reading, which I had previously acquired through the medium of the society library,—all the historical works in which I had at that time perused. At the expiration of a little more than half my apprenticeship, I suddenly conceived the idea of studying Latin.

"Through the assistance of an elder brother, who had himself obtained a collegiate education by his own exertions, I completed my Virgil during the evenings of one winter. After some time devoted to Cicero, and a few other Latin authors, I commenced

the Greek: at this time it was necessary that I should devote every hour of daylight, and a part of the evening, to the duties of my apprenticeship.

"Still I carried my Greek grammar in my hat, and often found a moment, when I was heating some large iron, when I could place my book open before me against the chimney of my forge, and go through with *tupto, tupteis, tuptei,* unperceived by my fellow-apprentices. At evening I sat down, unassisted, to the Iliad of Homer, twenty books of which measured my progress in that language during the evenings of another winter.

"I next turned to the modern languages, and was much gratified to learn that my knowledge of Latin furnished me with a key to the literature of most of the languages of Europe. This circumstance gave a new impulse to the desire of acquainting myself with the philosophy, derivation, and affinity of the different European tongues. I could not be reconciled to limit myself in these investigations, to a few hours, after the arduous labors of the day.

"I therefore laid down my hammer, and went to New Haven, where I recited to native teachers, in French, Spanish, German, and Italian. I returned, at the expiration of two years, to the forge, bringing with me such books in those languages as I could procure. When I had read these books through, I commenced the Hebrew, with an awakened desire of examining another field; and, by assiduous application, I was enabled in a few weeks to read this language with such facility, that I allotted it to myself as a task to read two chapters in the Hebrew Bible

before breakfast, each morning; this, and an hour at noon, being all the time that I could devote to myself during the day.

"After becoming somewhat familiar with this language, I looked around me for the means of initiating myself into the fields of Oriental literature; and, to my deep regret and concern, I found my progress in this direction hedged in by the want of requisite books. I began immediately to devise means of obviating this obstacle; and, after many plans, I concluded to seek a place as a sailor on board some ship bound to Europe, thinking in this way to have opportunities of collecting, at different ports, such works in the modern and Oriental languages as I found necessary for this object. I left the forge at my native place, to carry this plan into execution.

"I travelled on foot to Boston, a distance of more than a hundred miles, to find some vessel bound to Europe. In this I was disappointed; and, while revolving in my mind what steps next to take, I accidentally heard of the American Antiquarian Society, at Worcester. I immediately bent my steps toward this place. I visited the hall of the American Antiquarian Society, and found there, to my infinite gratification, such a collection in ancient, modern, and Oriental languages, as I never before conceived to be collected in one place; and, sir, you may imagine with what sentiments of gratitude I was affected, when, upon evincing a desire to examine some of these rich and rare works, I was kindly invited to unlimited participation in all the benefits of this noble institution.

"Availing myself of the kindness of the directors, I spent three hours daily at the hall, which, with an hour at noon, and about three in the evening, make up the portion of the day which I appropriate to my studies, the rest being occupied in arduous manual labor. Through the facilities afforded by this institution, I have added so much to my previous acquaintance with the ancient, modern, and Oriental languages, as to be able to read upwards of FIFTY of them with more or less facility."

This statement, however extraordinary it may seem, is well known to be but a modest account of Mr. Burritt's wonderful acquirements. He is still (1843) a practical blacksmith, yet he finds time to pursue his studies. Nor are his acquisitions his only merit. He has been frequently invited to deliver lectures before lyceums, and other associations, and in these he has displayed no small degree of eloquence and rhetorical power. As he is still a young man, we may venture to affirm that his history affords an instance of self-cultivation, which, having regard to all the circumstances, is without a parallel.

GEORGE MORLAND.

This eccentric man and clever artist was born in London, in 1763. He gave very early indications of genius, and when quite a child, used to draw objects on the floor, with the implements of his father, who was a painter, in crayons. He executed pictures of pencils, scissors, and other things of the kind, with so much perfection, that his father often mistook them for real ones, and stooped down to pick them up. Some

of George's drawings, executed before he was five years old, were exhibited with great applause at the society of artists in London.

These and other evidences of talent rendered him a favorite child; his father saw the germs of excellence in his own art, and, at the age of fourteen, had him apprenticed to himself, for seven years, during which his application was incessant. His father appears to have been harsh, unfeeling and selfish, and to have thought more of obtaining money from the talents and exertions of his son, than of giving him such training as should insure his success in life.

During his apprenticeship, George was confined to an upper room, copying drawings or pictures, and drawing from plaster casts. Being almost entirely restricted from society, all the opportunities he had for amusement were obtained by stealth, and his associates were a few boys in the neighborhood. The means of enjoyment were obtained by such close application to his business, as secretly to produce a few drawings or pictures more than his father imagined he could complete in a given time. These he lowered by a string from the window of his apartment, to his youthful companions, by whom they were converted into money, which they spent in common when opportunities offered.

In this manner passed the first seventeen years of the life of George Morland; and to this unremitted diligence and application he was indebted for the extraordinary power he possessed over the implements of his art. Avarice, however, was the ruling passion of his father, and this was so insatiable, that he kept

his son incessantly at work, and gave him little, if any, education, except as an artist. To this cause must doubtless be attributed the irregularities of his subsequent life.

Morland's earlier compositions were small pictures of two or three figures, chiefly from the ballads of the day. These his father put into frames and sold for from one to three guineas. They were remarkable for their simple truth, and were much admired. Many of them were engraved, and widely circulated, which gave the young artist an extensive reputation. About this time, he went to Margate to spend the summer, and, by the advice of a friend, commenced portrait painting there. Great numbers of fashionable persons came to sit to him, and he commenced several pictures.

But the society of accomplished people made him feel his own ignorance to such a degree as to render him unhappy, and he sought relief at pig races and in other coarse amusements, projected for the lower order of visitors at Margate. These at last engaged his whole attention, and the portraits were thrown aside, to be finished in town. He at last returned, with empty pockets and a large cargo of unfinished canvasses.

Morland continued, however, to rise rapidly in his profession, and he might easily have secured an ample fortune. The subjects he selected for his pencil, were, generally, rural scenes, familiar to every eye, and the sentiment they conveyed was felt by every beholder. Many of these were admirably engraved by the celebrated J. B. Smith, and immense numbers

were sold. Morland now had demands for more pictures than he could execute, and at almost any price.

But, unhappily, this gifted artist had already become addicted to the society of low picture dealers, and other dissipated persons, and his habits were, consequently, exceedingly irregular. His chief pleasures seemed to be—a ride into the country to a grinning match, a jolly dinner with a drinking bout after it, and a mad scamper home with a flounce in the mud.

Such, at last, was Morland's dislike of the society of gentlemen, and his preference of low company, that he would not paint pictures for the former class, but preferred selling them to certain artful dealers, who were his associates, and who flattered his vices, so that they might prey upon his genius. Of these persons, who pretended to be his friends, he did not obtain more than half price for his paintings. This system was carried to such an extent that Morland was at last entirely cut off from all connection with the real admirers of his works. If a gentleman wished to get one of his pictures, he could only do it by employing one of these harpies who had access to the artist, and who would wheedle a picture out of him for a mere trifle, and all under the mask of friendship.

About the year 1790, Morland lived in the neighborhood of Paddington. At this period, he had reached the very summit of his professional fame, and also of his extravagance. He kept, at one time, no less than eight saddle horses at livery, at the sign

of the White Lion, opposite to his house, and affected to be a good judge of horse-flesh. Frequently, horses, for which one day he would give thirty or forty guineas, he would sell the next, for less than half that sum; but as the honest fraternity of horse-dealers knew their man, and would take his note at two months, he could the more easily indulge this propensity, and appear, for a short time, in cash, until the day of payment came, when a picture was produced as a douceur for a renewal of the notes.

This was one source of calamity which neither his industry, for which he was not remarkable, nor his talents, were by any means adequate to overcome. His wine merchant, who was also a gentleman in the discounting line, would sometimes obtain a picture worth fifty pounds, for the renewal of a bill. By this conduct, he heaped folly upon folly, to such a degree, that a fortune of ten thousand a year would have proved insufficient for the support of his waste and prodigality.

Morland's embarrassments, which now crowded upon him, were far from producing any change in his conduct; and, at length, they conducted him, through the hands of a bailiff, into prison, of which, by the way, he had always entertained a foreboding apprehension. This, however, did not render him immediately unhappy, but rather afforded him an opportunity of indulging, without restraint of any kind, his fatal propensities. There, he could mingle with such companions as were best adapted to his taste, and there too, in his own way, he could, without check or

control, reign or revel, surrounded by the very lowest of the vicious rabble.

When in confinement, and even sometimes when he was at liberty, it was common for him to have four guineas a day and his drink,—an object of no small consequence, as he began to drink before he began to paint, and continued to do both alternately, till he had painted as much as he pleased, or till the liquor had completely overcome him, when he claimed his money, and business was at an end for that day.

This laid his employer under the necessity of passing his whole time with him, in order to keep him in a state fit for labor, and to carry off the day's work when it was done; otherwise some eavesdropper snapped up his picture, and his employer was left to obtain what redress he could. By pursuing this fatal system, he ruined his health, enfeebled his genius, and sunk himself into general contempt. His constitution could not long sustain such an abuse of its powers. He was attacked with paralysis, and soon after, he died.

Thus perished George Morland, at the early age of forty-one years; a man whose best works will command esteem as long as any taste for the art of painting remains; one whose talents might have insured him happiness and distinction, if he had been educated with care, and if his entrance into life had been guided by those who were able and willing to caution him against the snares which are continually preparing by knavery for the inexperience and heedlessness of youth. Many of the subjects of Mor-

land's pencil, are such as, of themselves, are far from pleasing. He delighted in representations of the pigsty. Yet even these, through the love we possess of truthful imitations, and the hallowing powers of genius, excite emotions of pleasure. His pictures of scenery around the cottage door, and of those rustic groups familiar to every eye, have the effect of poetry, and call into exercise those gentle sentiments, which, however latent, exist in every bosom. It is sad to reflect, that one who did so much to refine and civilize mankind, should himself have been the victim of the coarsest of vices.

WILLIAM PENN.

THIS remarkable man was born in the parish of St Catherine's, near the tower of London, on the 14th day of October, 1644. His father, who served in the time of the Commonwealth, in some of the highest maritime offices, was knighted by Charles the Second,

and became a peculiar favorite of the then Duke of York.

Young Penn had good advantages for education, and made such early improvement, that, about the fifteenth year of his age, he was entered a student in Christ's Church College, Oxford, where he continued two years. He delighted much in manly sports at times of recreation; but at length, being influenced by an ardent desire after pure and spiritual religion, of which he had before received some taste through the ministry of Thomas Lee, one of the people denominated Friends, or Quakers, he, with certain other students of that University, withdrew from the national way of worship, and held private meetings for the exercise of religion. Here they both preached and prayed among themselves. This gave great offence to the heads of the college, and young Penn, being but sixteen years of age, was fined for non-conformity, and at length, for persevering in his peculiar religious practices, was expelled the college.

Having in consequence returned home, he still took great delight in the company of sober and religious people. His father, perceiving that this would be an obstacle in the way of his son's preferment, endeavored by words, and even very severe measures, to persuade him to change his conduct. Finding these methods ineffectual, he was at length so incensed, that he turned young William out of doors. The latter was patient under this trial, and at last the father's affection subdued his anger. He then sent his son to France, in company with some persons of quality that were making a tour thither.

He continued in France a considerable time, and, under the influence of those around him, his mind was diverted from religious subjects. Upon his return, his father, finding him not only a proficient in the French language, but also possessed of courtly manners, joyfully received him, hoping now that his point was gained. . Indeed, some time after his return from France, his carriage was such as justly to entitle him to the character of a finished gentleman.

"Great about this time," says one of his biographers, "was his spiritual conflict. His natural inclination, his lively and active disposition, his father's favor, the respect of his friends and acquaintance, strongly pressed him to embrace the glory and pleasures of this world, then, as it were, courting and caressing him, in the bloom of youth, to accept them. Such a combined force seemed almost invincible; but the earnest supplication of his soul being to the Lord for preservation, He was pleased to grant such a portion of his power or spirit, as enabled him in due time to overcome all opposition, and with an holy resolution to follow Christ, whatsoever reproaches or persecutions might attend him."

About the year 1666, and when he was twenty-two years of age, his father committed to his care and management a considerable estate in Ireland, which occasioned his residence in that country. Thomas Lee, whom we have before mentioned, being at Cork, and Penn hearing that he was to be shortly at a meeting in that city, went to hear him; and by the preaching of this man, which had made some impression on his mind ten years before, he was now thoroughly and

effectually established in the faith of the Friends, and afterwards constantly attended the meetings of that people. Being again at a meeting at Cork, he, with many others, was apprehended, and carried before the mayor, and, with eighteen of his associates, was committed to prison; but he soon obtained his discharge. This imprisonment was so far from terrifying, that it strengthened him in his resolution of a closer union with that people, whose religious innocence was the only crime for which they suffered. He now openly joined with the Quakers, and brought himself under the reproach of that name, then greatly ridiculed and hated. His former companions turned their caresses and compliments into bitter gibes and malignant derision.

His father, receiving information of what had passed, ordered him home; and the son readily obeyed. His deportment attested the truth of the information his father had received. He now again attempted, by every argument in his power, to move him; but finding it impossible to obtain a general compliance with the customs of the times, he would have borne with him, provided he would have taken off his hat, in the presence of the king, the duke of York, and himself.

This being proposed to the son, he desired time to consider of it. His father, supposing this to be with an intention of consulting his friends, the Quakers, assured him that he should see the face of none of them, but retire to his chamber till he could return him an answer. "Accordingly he withdrew, humbling himself before God, with fasting and supplication, to know his heavenly mind and will, and became

so strengthened in his resolution, that, returning to his father, he humbly signified that he could not comply with his desire."

All endeavors proving ineffectual to shake his constancy, his father, seeing himself utterly disappointed in his hopes, again turned him out of doors. After a considerable time, his steady perseverance evincing his integrity, his father's wrath became somewhat abated, so that he winked at his return to, and continuance with, his family; and though he did not publicly seem to countenance him, yet, when imprisoned for being at meetings, he would privately use his interest to get him released. In the twenty-fourth year of his age, he became a minister among the Quakers, and continued his useful labors, inviting the people to that serenity and peace of conscience he himself witnessed, till the close of his life.

A spirit warmed with the love of God, and devoted to his service, ever pursues its main purpose; thus, when restrained from preaching, Penn applied himself to writing. The first of his publications appears to have been entitled "Truth Exalted." Several treatises were also the fruits of his solitude, particularly the one entitled "No Cross, no Crown."

In the year 1670, came forth the Conventicle Act, prohibiting Dissenters' meetings, under severe penalties. The edge of this new weapon was soon turned against the Quakers, who, not accustomed to flinch in the cause of religion, stood particularly exposed. Being forcibly kept out of their meeting-house in Grace Church street, they met as near it, in the open street, as they could: and Penn, preaching there, was appre-

hended, and committed to Newgate. At the next sessions of the Old Bailey, together with William Mead, he was indicted for "being present at, and preaching to, an unlawful, seditious, and riotous assembly." At his trial he made a brave defence, discovering at once both the free spirit of an Englishman and the undaunted magnanimity of a Christian, insomuch that, notwithstanding the frowns and menaces of the bench, the jury acquitted him.

Not long after this trial, and his discharge from Newgate, his father died, perfectly reconciled to his son, and left him both his paternal blessing, and an estate of fifteen hundred pounds a year. He took leave of his son with these remarkable words: "Son William, if you and your friends keep to your plain way of preaching, and keep to your plain way of living, you will make an end of the priests to the end of the world. Bury me by my mother; live all in love; shun all manner of evil; and I pray God to bless you all; and he will bless you."

In February, 1670, Penn was preaching at a meeting in Wheeler street, Spitalfields, when he was pulled down, and led out by soldiers into the street, and carried away to the Tower, by order of Sir John Robinson, lieutenant of the Tower. He was examined before Sir John and several others, and then committed, by their orders, to Newgate, for six months. Being at liberty at the expiration of that time, he soon after went to Holland and Germany, where he zealously endeavored to propagate the principles of the Quakers.

In March, 1680, he obtained from Charles II. a grant of the territory which now bears the name of

Pennsylvania. This was in compensation of a crown debt due to his father. Having previously published an account of the province, inviting emigrants to accompany him thither, he set sail in June, 1682, with many friends, especially Quakers, and after a prosperous voyage of six weeks, they came within sight of the American coast. Sailing up the river Delaware, they were received by the inhabitants with demonstrations of joy and satisfaction. Having landed at Newcastle, a place mostly inhabited by the Dutch, Penn next day summoned the people to the courthouse, where possession of the country was legally given him.

Having invited the Indians to meet him, many chiefs and persons of distinction, appointed to represent them, came to see him. To these he gave several valuable presents, the produce of English manufactures, as a testimony of that treaty of amity and good understanding, which, by his benevolent disposition, he ardently wished to establish with the native inhabitants. He made a most favorable impression upon the savages, and thus secured to Pennsylvania their favor. He then more fully stated the purpose of his coming, to the people, and the benevolent object of his government, giving them assurances of the free enjoyment of liberty of conscience in things spiritual, and of perfect civil freedom in matters temporal. He recommended to them to live in sobriety and peace one with another. After about two years residence in the country, all things being in a thriving and prosperous condition, he returned to England; and James II. coming soon after to the throne, he was taken into

favor by that monarch, who, though a bigot in religion, was nevertheless a friend to toleration.

At the revolution, being suspected of disaffection to the government, and looked upon as a Papist or a Jesuit, under the mask of a Quaker, he was examined before the Privy Council, Dec., 1688; but, on giving security, was discharged. In 1690, when the French fleet threatened a descent on England, he was again examined before the council, upon an accusation of corresponding with King James, and was held to bail for some time, but was released in Trinity Term. He was attacked a third time the same year, and deprived of the privilege of appointing a governor for Pennsylvania; till, upon his vindication, he was restored to his right of government. He designed now to go over a second time to Pennsylvania, and published proposals in print for another settlement there; when a fresh accusation appeared against him, backed by one William Fuller, who was afterwards declared by parliament to be a notorious imposter. A warrant was granted for Penn's apprehension, which he narrowly escaped at his return from the funeral of George Fox, the founder and head of the Quakers. He now concealed himself for two or three years, and during this recess, wrote several pieces. At the end of 1693, through the interest of Lord Somers and others, he was allowed to appear before the king and council, when he represented his innocence so effectually that he was acquitted.

In 1699, he again went out to Pennsylvania, accompanied by his family, and was received by the colonists with demonstrations of the most cordial welcome.

During his absence, some persons endeavored to undermine the American proprietary governments, under pretence of advancing the prerogative of the crown, and a bill for that purpose was brought into the H. of Lords. Penn's friends, the proprietors and adventurers then in England, immediately represented the hardships of their case to the parliament, soliciting time for his return, to answer for himself, and accordingly pressing him to come over as soon as possible. Seeing it necessary to comply, he summoned an assembly at Philadelphia, to whom, Sept. 15th, 1701, he made a speech, declaring his reasons for leaving them; and the next day he embarked for England, where he arrived about the middle of December. After his return, the bill, which, through the solicitations of his friends, had been postponed the last session of parliament, was wholly laid aside.

In the year 1707, he was unhappily involved in a suit at law with the executors of a person who had been formerly his steward, against whose demands he thought both conscience and justice required his endeavors to defend himself. But his cause, though many thought him aggrieved, was attended with such circumstances, that the court of chancery did not think it proper to relieve him; wherefore he was obliged to dwell in the Old Bailey, within the rules of the Fleet, some part of this and the ensuing year, until such time as the matter in dispute was accommodated.

In the year 1710, the air of London not agreeing with his declining constitution, he took a seat at Rushcomb, in Buckinghamshire. Here he experienced

three successive shocks of apoplexy in 1712, the last of which sensibly impaired his memory and his understanding. His religious zeal, however, never abated, and up to 1716, he still frequently went to the meeting at Reading. Two friends calling upon him at this time, although very weak, he expressed himself sensibly, and when they were about to take leave of him, he said, "My love is with you; the Lord preserve you, and remember me in the Everlasting Covenant."

After a life of ceaseless activity and usefulness, Penn closed his earthly career on the 13th of May, 1718, in the seventy-sixth year of his age. He was buried at Jourdans, in Buckinghamshire, where several of his family had been interred.

JOHN SMITH.

THERE are few names that excite more interest or awaken more romantic associations than that of Captain John Smith. He passed through a series of the most remarkable events in Europe; and coming to our country at a period which was favorable to the exercise of his peculiar genius, he became the hero of many stirring adventures.

He was born at Willoughby, in the county of Lincolnshire, England, in the year 1579, and was descended from an ancient family. He displayed a love of enterprise in his early childhood, and he says that at thirteen years old he was "set upon brave adven-

tures." This disposition led him to dispose of his books, his satchel, and what other little property he had, for the purpose of raising money to take him to sea; but losing his parents about this time, he received from them a considerable fortune. He was now induced to change his plans, and became apprenticed to an eminent merchant in London.

As might be expected, the drudgery and confinement of a compting house were very distasteful to one who was bent upon adventure; accordingly, with but ten shillings in his pocket, he became a follower of the son of Lord Willoughby, who was going to France. When he arrived there, he went into the service of Captain Joseph Duxbury, with whom he remained four years in Holland. How he was occupied during this period is uncertain. About this time, a Scotch gentleman kindly gave him some money, and letters to Scotland, assuring him of the favor of King James.

Smith now set sail, and arrived in Scotland after many disasters by sea, and great sickness of body. He delivered his letters, and was treated with kindness and hospitality; but his stay was short. Returning to his native town, and disappointed in not having found food for his wild love of adventure, he went into a forest, built himself a sort of hut, and studied military history and tactics. Here he lived for a time, being provided by his servant with the comforts of civilization, at the same time that he pleased his imagination with the idea of being a hermit. Accident throwing him into the society of an Italian gentleman, in military service, his ardor for

active life was revived, and he set out again upon his travels, intending to fight against the Turks.

Being robbed of all his baggage and property in the Low Countries by some dastardly Frenchmen, he fortunately met with great kindness and generosity from several noble families. Prompted, however, by the same restless spirit with which he commenced life, he left those who were strongly interested in his welfare, and set out upon a journey, with a light purse and a good sword. In the course of his travels, he was soon in such a state of suffering from hunger and exposure, that he threw himself down in a wood, and there expected to die. But relief again appeared; a rich farmer chanced to come that way, who, upon hearing his story, supplied his purse, thus giving him the means of prosecuting his journey. There is scarcely an instance on record of a stranger receiving such kindness from his fellow-men, as did this same Smith.

He now went from port to port in search of a ship of war. During his rambles, he met, near a town in Brittany, with one of the villains who had robbed him. Smith immediately fought and vanquished him, making him confess his villany before a crowd of spectators. He then went to the seat of the Earl of Ployer, who gave him money, with which he embarked from Marseilles for Italy, in a ship in which there was a number of Catholic pilgrims of various nations. A furious storm arising, these devotees took it into their heads that Heaven, in anger at the presence of a heretic, thus manifested its displeasure. They, therefore, set upon our hero, who, in spite of a

valorous defence, was, like a second Jonah, thrown into the sea; but whether the angry elements were appeased by the offering, history saith not.

Being near the island of Saint Mary's, Smith easily swam thither, and was the next day taken on board a French ship, the commander of which, fortunately for Smith, was a friend of the Earl of Ployer, and treated him with great kindness. They then sailed to Alexandria, in Egypt. In the course of their voyage in the Levant, they met with a rich Venetian merchant ship, which, taking the French ship for a pirate, fired a broadside into her. This rough salutation, of course, brought on an engagement, in which the Venetians were defeated, and her cargo taken on board the victorious ship. Smith here met with something congenial to his wild and reckless spirit; and showing great valor on the occasion, he was rewarded with a large share of the booty. With this, he was enabled to travel in Italy, gratifying his curiosity by the interesting objects with which that country is filled. He at length set off for Gratz, the residence of Ferdinand, Archduke of Austria, and afterwards emperor of Germany.

The war was now raging between Rodolph, emperor of Germany, and Mahomet III., Grand Seignor of Turkey. Smith, by the aid of two of his countrymen, became introduced to some officers of distinction in the imperial army, who were very glad to obtain so valiant a soldier as Smith was likely to prove. This was in the year 1601. The Turkish army, under the command of Ibrahim Pasha, had besieged and taken a fortress in Hungary, and were ravaging

the country. They were also laying siege to Olympach, which they had reduced to extremity.

Baron Kissel, who annoyed the besiegers from without, was desirous of sending a message to the commander of the garrison. Here was now an opportunity for Smith's talents and prowess to come into play. He entered upon his duty, and by means of telegraphs, he communicated the desired intelligence to the besieged fortress; and then, exercising his ingenuity, he arranged some thousands of matches on strings, so that when they were fired, the report deceived the Turks into the idea that a body of men were there. They consequently marched out to attack them. Smith's forces, with those of the garrison, which had been duly apprized of the scheme, fell upon them, and routed them. The Turks were now obliged to abandon the siege. This brilliant and successful exploit placed our hero at the head of a troop of two hundred and fifty horse, in the regiment of Count Meldritch.

The next adventure in which Smith's ingenuity was called into exercise was at the siege of Alba Regalis, in Hungary. He here contrived a sort of bomb, by which the Turks were greatly annoyed and their city set on fire; a bold military manœuvre being adopted at the critical moment, the place was taken, the Turks suffering great loss. A number of sieges and undecisive skirmishes now followed, which brought upon the Christians the jeers and scoffs of the Turks. One of their number, Lord Turbashaw, a man of military renown, sent a challenge to any captain of the Christian army to fight with him in

single combat. The choice fell upon Smith, who ardently desired to meet the haughty Mussulman.

The day was appointed, the ground selected and lined with warlike soldiers and fair ladies. Lord Turbashaw entered the lists in splendid gilt armor, with wings on his shoulders, of eagle's feathers, garnished with gold and jewels. A janizary bore his lance, and two soldiers walked by the side of his horse. Smith was attended only by a page, bearing his lance. He courteously saluted his antagonist, and, at the sound of the trumpet, their horses set forward. They met with a deadly shock. Smith's lance pierced the visor of the Turk, and he fell dead from his horse. The day after, another challenge was sent to Smith; another encounter took place; and he was again victorious. Still another challenge met with the same result, and Smith was rewarded for his prowess in a signal manner, being made major of his regiment, and receiving all sorts of military honors. The Prince of Transylvania gave him a pension of three hundred ducats a year, and bestowed upon him a patent of nobility.

These events occurred about the year 1600. Various military movements followed in Moldavia, Smith taking an active part in whatever of enterprise and daring was going forward. In one instance, he narrowly escaped with his life.

In a mountainous pass, he was decoyed into an ambuscade, and though the christians fought desperately, they were nearly all cut to pieces. Smith was wounded and taken, but his life was spared by the cupidity of the conquerors, who expected a large sum

for his ransom. He was sold as a slave and sent to Constantinople. He was afterwards removed to Tartary, where he suffered abuse, cruelty, and hardships of every description. At last he seized a favorable opportunity, rose against his master, slew him, clothed himself in his dress, mounted his horse, and was again at liberty.

Roaming about in a vast desert for many days, chance at length directed him to the main road, which led from Tartary to Russia, and in sixteen days he arrived at a garrison, where the governor and his lady took off his irons and treated him with great care and kindness. Thence he travelled into Transylvania, where he arrived in 1603. Here he met many of his old companions in arms, who overwhelmed him with honors and attentions. They had thought him dead, and rejoiced over him as one risen from the grave.

Still unsatisfied with perils and honors, hearing that a civil war had broken out in Barbary, he sailed to Africa, but, not finding the cause worthy of his sword, he returned to England in 1604, where a new field of adventure opened before him. Attention had been awakened in England upon the subject of colonizing America, by the representation of Captain Gosnold, who, in 1602, had made a voyage to the coast of New England. He gave delightful accounts of the fertility of the country and salubrity of the climate, and was anxious to colonize it. Of course, this plan was embraced with ardor by Smith, being a project just suited to his roving disposition, and his love for "hair breadth 'scapes."

James I., who was now king, being inclined to the plan, an expedition was fitted out in 1606, of one hundred and five colonists, in three small vessels. Among the foremost of the adventurers were Gosnold and Smith, who seemed to be drawn together by a kind of instinct. After a voyage of four months, in which dissensions and mutiny caused much trouble and uneasiness, and which resulted in Smith's imprisonment during the voyage, the colonists arrived at Chesapeake Bay in April, 1607. The landscape, covered with the new grass of spring, and varied with hills and valleys, seemed like enchantment to the worn-out voyagers. With joy they left their ships, and passed many days in choosing a spot for a resting-place and a home.

Here new troubles assailed them. The Indians in the vicinity looked upon their encroachments with jealous eyes, and attacked them with their arrows, but the colonists quickly dispersed them with muskets. Others, however, more peaceable, treated our adventurers with kindness. A settlement was now made upon a peninsula on James's river, to which they gave the name of Jamestown.

Of course, in a settlement like this, there must be suffering, and consequently, discontent. Much of this was manifested towards Smith, who, by his energy and perseverance, excited the envy of those associated with him in the management of the infant colony. At the same time, he became the object of dread to the Indians, by his bravery and resources. Many of the colonists died of hunger and disease; many were dispirited; and at last, in despair, they

turned to our adventurer as their only hope in this hour of need. Like all generous spirits, he forgot his injuries, and set himself to work to remedy the evils that beset them. By his ingenuity and daring, he obtained from the Indians liberal supplies of corn, venison, and wild fowl, and, under the influence of good cheer, the colonists became, comparatively, happy.

But a new and unforeseen calamity awaited our hero. Having penetrated into the country, with but few followers, he was beset by a large party of Indians, and, after a brave resistance, was taken prisoner. But the spirit and presence of mind of this remarkable man did not forsake him in this alarming crisis. He did not ask for life, for this would, probably, have hastened his death; but requesting that he might see the Indian chief, he at the same time drew from his pocket a compass, and directed attention to it, partly by signs and partly by words which he had learned. The curious instrument amused and surprised his savage captors, and averted, for a time, the fate that awaited him.

They soon, however, tied him to a tree, and prepared to shoot him with their arrows. Changing their plans suddenly, they led him in a procession to a village, where they confined him and fed him so abundantly, that Smith thought they were probably fattening him for food. After a variety of savage ceremonies, the Indians took him to Werowcomoco—the residence of Powhatan, a celebrated chief, of a noble and majestic figure, and a countenance bespeaking the severity and haughtiness of one whose nod is law.

Powhatan was seated on a throne, with one of his daughters on each side of him. Many Indians were standing in the hut, their skins covered with paint, and ornamented with feathers and beads. As Smith was brought bound into the room, there was a loud shout of triumph, which warned him that his last hour had arrived. They gave him water to wash, and food to eat, and then, holding a consultation, they determined to kill him. Two large stones were brought in and placed before the unbending chief. Smith was dragged forward, his head placed upon the stones, and the fatal club raised for the cruel deed.

But what stays the savage arm? A child of twelve or thirteen, Pocahontas by name, the chief's favorite child, melted by the pity that seldom moves the heart of her race, ran to our hero, clasped his head in her arms, laid herself down with him on the block, determined to share his fate. Surely, of the numberless acts of kindness and benevolence which had been showered at different times upon Smith, this transcended them all! Startled by the act, and perhaps sympathizing with the feelings of his child, Powhatan raised Smith from the earth, and in two days, sent him with twelve Indian guides to Jamestown, from which place he had been absent seven weeks.

Smith found the colony disheartened by his absence, and in want of provisions. These he procured from the Indians, bartering blue beads for corn and turkeys. A fire broke out about this time, and burned up many of the houses of the colony; this damage, however, Smith set about repairing—his patience and energy surmounting every evil.

In June, 1608, our adventurer, tired of his mode of life, set out, with fourteen others, to explore Chesapeake Bay and the Potomac river. They encountered many tribes of Indians, but Smith's boldness always averted their assaults; and his frank and open demeanor generally turned his enemies into friends. The party returned to Jamestown in July, when Smith was made the president of the colony.

He now made several expeditions, frequently meeting with adventures, and falling in with numerous tribes of Indians. He and his party had many skirmishes, and suffered considerably from the assaults of the savages; but Smith's sagacity and ingenuity rendered them comparatively harmless. He explored the whole of Chesapeake Bay, sailing nearly 3000 miles, in the space of three months.

About this time, an expedition arrived from the mother country, under Capt. Newport, whose object was to make discoveries, and as they were to pass through Powhatan's territories, it was thought best to secure his favor by various presents. Accordingly, a bed and hangings, a chair of state, a suit of scarlet clothes, a crown, and other articles, were presented to him with great ceremony. At his coronation, having been with difficulty persuaded by the English to kneel, the moment the crown touched his head, a volley was fired from the boats, which caused the newly-made monarch to start up with affright. By way of return for these honors, Powhatan generously presented Captain Newport with his old shoes and mantle!

Notwithstanding Smith's exertions in behalf of the

colony, the council in England were constantly dissatisfied with him. But he did not allow anything to abate his zeal for the welfare of the colony under his command; even though they were harassed by the Indians, and suffering from sickness and privation, he still kept up his courage and energy. He entreated the managers in England to send them out mechanics and husbandmen, instead of the idle young gentlemen who had come with Newport, and took every step in his power to promote the prosperity of the settlement.

The colony being now in great want of supplies, Smith made many exertions to procure them, but the Indians refused to part with any more provisions. A great war of words ensued between Smith and Powhatan, which ended in hostilities, Smith endeavoring to take the latter prisoner. The Indians, in their turn, made preparations to attack the English by night. Of this, they were warned by Pocahontas, who continued her kind interpositions in favor of Smith.

Our hero had now experienced, it would seem, enough of adventure and peril to satisfy his desires. He often narrowly escaped with his life, for the Indians held him in dread, as one to whose prowess they were always obliged to yield, and whose address was always an overmatch for their own. If they suspected him of any hostile intentions towards them, they propitiated him by loads of provisions. To give some idea of this—Smith returned from one of his expeditions with two hundred pounds of deer's flesh, and four hundred and seventy-nine bushels of corn. But at length, growing weary of exertion, and of the

animadversion of the English company, with trouble abroad, and mutiny and sickness at home, he returned to England in 1609.

From this period to 1614, little or nothing is known of him. At this date, we again find him, true to his nature, sailing with two ships to Maine, for the purpose of capturing whales and searching for gold. Failing in these expectations, Smith left his men fishing for cod, while he surveyed the coast, from Penobscot to Cape Cod, trafficking with the Indians for furs. He then returned to England, and gave his map to the king, Charles I., and requested him to change some of the barbarous names which had been given to the places discovered. Smith gave the country the name of New England. Cape Cod, the name given by Gosnold, on account of the number of codfish found there, was altered by King Charles to Cape James, but the old title has always been retained. With the modesty ever manifested by Smith, he gave his own name only to a small cluster of islands, which, by some strange caprice, are now called the Isles of Shoals.

In January, 1615, Captain Smith set sail for New England, with two ships, from Plymouth in England, but was driven back by a storm. He embarked again in June, but met with all kinds of disasters, and was at last captured by a French squadron, and obliged to remain all summer in the admiral's ship. When this ship went to battle with English vessels, Smith was sent below; but when they fell in with Spanish ships, they obliged him to fight with them. They at length carried him to Rochelle, where they put him on board

a ship in the harbor. This was but a miserable existence to our hero, and he sought various opportunities of escape.

At length, a violent storm arising, all hands went below, to avoid the pelting rain, and Smith pushed off in a boat, with a half pike for an oar, hoping to reach the shore. But a strong current carried him out to sea, where he passed twelve hours in imminent danger, being constantly covered with the spray. At last, he was thrown upon a piece of marshy land, where some fowlers found him, nearly drowned. He was relieved and kindly treated at Rochelle, and soon returned to England.

While these adventures were happening to Smith, Pocahontas became attached to an English gentleman, of the name of Rolfe, having previously separated herself from her father. This would seem an unnatural step, were it not for the fact that she had a more tender and mild nature than that of her nation, and could not endure to see the cruelties practised against the English, in whom she felt so strong an interest. She was married in 1613, and by means of this event a lasting peace was established with Powhatan and his tribe.

In 1616, Pocahontas visited England with her husband. She had learned to speak English well, and was instructed in the doctrines of Christianity. As soon as Smith heard of her arrival, he went immediately to see her, and he describes her in this interview as "turning about and obscuring her face," no doubt, overcome by old recollections. She afterwards, however, held a long conversation with Smith. This *interesting* creature was not destined to return to her

own land, for, being taken sick at Gravesend, in 1617, she died, being only twenty-two years old.

Much has been written concerning this friend of the whites, and all agree in ascribing to her character almost every quality that may command respect and esteem. She combined the utmost gentleness and sweetness, with great decision of mind and nobleness of heart. Captain Smith has immortalized her by his eloquent description of her kindness to him and his people. From her child are descended some honorable families now living in Virginia.

Captain Smith intended to sail for New England in 1617, but his plans failed, and he remained in England, using constant exertions to persuade his countrymen to settle in America. In 1622, the Indians made a dreadful massacre at Jamestown, destroying three hundred and forty-seven of the English settlers. This news affected Smith very much, and he immediately made proposals to go over to New England, with forces sufficient to keep the Indians in check. But the people of England made so many objections to the plan, that it was given up by our hero, though with great regret. From this period, his story is little known, and we are only told that he died in 1631. His life is remarkable for the variety of wild adventures in which he was engaged; his character is marked as well by courage and daring, as by the somewhat opposite qualities of boldness and perseverance. He seems also to have possessed many noble and generous qualities of heart. He had, indeed, the elements of greatness, and had he been called to a wider field of action, he might have left a nobler fame among the annals of mankind.

ETHAN ALLEN.

This extraordinary man was born at Litchfield, or Salisbury, Connecticut, about the year 1740. He had five brothers and two sisters, named Heman, Heber, Levi, Zimri, Ira, Lydia and Lucy. Four or five of the former emigrated to Vermont, with Ethan, where their bold, active and enterprising spirits found an abundant opportunity for its display. Many a wild legend, touching their adventures, still lingers among the traditions of the Green Mountains.

About the year 1770, a dispute between New York and New Hampshire, as to the dividing line between the two provinces, and which had long been pending, came to a crisis. The territory of Vermont was claimed by both parties; and some of the settlers who had received grants from Governor Wentworth, of New Hampshire, were threatened with being ejected from their lands by legal processes, proceeding from the province of New York.

The Allens had selected their lands in the township of Bennington, which had now become a considerable place. The New York government, in conformity with their interpretation of their rights,

had proceeded to grant patents, covering these very lands on which farms had now been brought to an advanced state of culture, and where houses had been built and orchards planted by the original purchasers. These proprietors were now called upon to take out new patents, at considerable expense, from New York, or lose their estates.

This privilege of purchasing their own property was regarded by the Vermonters as rather an insult, than a benefit, and most of them refused to comply. The question was at last brought to trial at Albany, before a New York court, Allen being employed by the defendants as their agent. The case was, of course, decided against them, and Allen was advised, by the king's attorney-general, to go home and make the best terms he could with his new masters, remarking, that "might generally makes right." The reply of the mountaineer was brief and significant: "The gods of the valley are not the gods of the hills;" by which he meant that the agents of the New York government would find themselves baffled at Bennington, should they undertake to enforce the decision of the court, against the settlers there.

Allen's prediction was prophetic. The sheriffs sent by the government were resisted, and finally, a considerable force was assembled, and placed under the command of Allen, who obliged the officers to desist from their proceedings. A proclamation was now issued by the governor of New York, offering a reward of twenty pounds for the apprehension of Allen. The latter issued a counter proclamation, offering a reward of five pounds to any one who

would deliver the attorney-general of the colony into his power.

Various proceedings took place, and for several years, the present territory of Vermont presented a constant series of disturbances. The New York government persevered in its claims, and the settlers as obstinately resisted. In all these measures, whether of peace or war, Allen was the leader of the Green Mountain yeomanry. Various plots were laid for his apprehension, but his address and courage always delivered him from the impending danger. At last, the revolution broke out, and the dispute was arrested by events which absorbed the public attention. The rival claims being thus suspended, the people of Vermont were left to pursue their own course.

A few days after the battle of Lexington, a project was started at Hartford, Connecticut, for the capture of Fort Ticonderoga, then belonging to the British. Several persons set out upon this enterprise, and taking Bennington in their way, Allen joined them with some of his "Green Mountain Boys," and was appointed commander of the expedition. The little band arrived, without molestation, on the banks of Lake George, opposite the fort. They procured boats sufficient to carry eighty-three men. These crossed in the night, and landed just at the dawn of day. While the boats were gone back with the remainder of the troops, Allen resolved to attack the fort.

He drew up the men in three ranks, addressed them in a short harangue, ordered them to face to the right, and placing himself at the head of the middle file, led them silently, but with a quick step, up the heights

where the fortress stood; and before the sun rose, he had entered the gate, and formed his men on the parade between the barracks. Here they gave three huzzas, which aroused the sleeping inmates. When Colonel Allen passed the gate, a sentinel snapped his fusee at him, and then retreated under a covered way. Another sentinel made a thrust at an officer with a bayonet, which slightly wounded him. Colonel Allen returned the compliment with a cut on the side of the soldier's head, at which he threw down his musket, and asked quarter.

No more resistance was made. Allen now demanded to be shown to the apartment of Captain Delaplace, the commander of the garrison. It was pointed out, and Allen, with Beman, his guide, at his elbow, hastily ascended the stairs, which were attached to the outside of the barracks, and called out with a voice of thunder at the door, ordering the astonished captain instantly to appear, or the whole garrison should be sacrificed.

Startled at so strange and unexpected a summons, the commandant sprang from his bed and opened the door, when the first salutation of his boisterous and unseasonable visitor was an order immediately to surrender the fort. Rubbing his eyes, and trying to collect his scattered senses, the captain asked by what authority he presumed to make such a demand. "In the name of the Great Jehovah, and the Continental Congress!" said Allen.

Not accustomed to hear much of the continental congress in this remote corner, nor to respect its authority when he did, the commandant began to

remonstrate; but Colonel Allen cut short the thread of his discourse, by lifting his sword over his head, and reiterating the demand for an immediate surrender. Having neither permission to argue, nor power to resist, Captain Delaplace submitted, ordering his men to parade, without arms, and the garrison was given up to the victors.*

The fruit of this victory was about fifty prisoners, with one hundred and twenty pieces of cannon, beside other arms and military stores. A few days after, the fort at Crown Point was taken, and some other successful enterprises were achieved. Allen obtained great credit by these performances.

In the following autumn, he was twice despatched into Canada, to engage the inhabitants to lend their support to the American cause. In the last of these expeditions, he formed a plan, in concert with Colonel Brown, to reduce Montreal. Allen, accordingly, crossed the river in September, 1775, at the head of one hundred and ten men, but was attacked, before Brown could join him, by the British troops, consisting of five hundred men, and, after a most obstinate resistance, was taken prisoner. The events of his captivity he himself has recorded in a narrative compiled after his release, in the most singular style, but apparently with great fidelity.

For some time he was kept in irons, and treated with much severity. He was sent to England as a prisoner, with an assurance that, on his arrival there, he would meet with the halter. During the passage,

* Sparks' Biography.

extreme cruelty was exercised towards him and his fellow-prisoners. They were all, to the number of thirty-four, thrust, handcuffed, into a small place in the vessel, not more than twenty feet square. After about a month's confinement in Pendennie castle, near Falmouth, he was put on board a frigate, January 8, 1776, and carried to Halifax. Thence, after an imprisonment of five months, he was removed to New York.

On the passage from Halifax to the latter place, he was treated with great kindness by Captain Smith, the commander of the vessel, and he evinced his gratitude by refusing to join in a conspiracy on board to kill the British captain and seize the frigate. His refusal prevented the execution of the plan. He remained at New York for a year and a half, sometimes in confinement, and sometimes at large, on parole.

In 1778, Allen was exchanged for Colonel Campbell, and immediately afterwards, repaired to the head quarters of General Washington, by whom he was received with much respect. As his health was impaired, he returned to Vermont, after having made an offer of his services to the commander-in-chief, in case of his recovery. His arrival in Vermont was celebrated by the discharge of cannon; and he was soon appointed to the command of the state militia, as a mark of esteem for his patriotism and military talents. A fruitless attempt was made by the British to bribe him to lend his support to a union of Vermont with Canada. He died suddenly at his estate at Colchester, February 13, 1789.

Allen was a man of gigantic stature, being nearly seven feet in height, and every way of relative proportions. He possessed undaunted courage, and blended bold enterprise with much sagacity. His early education was imperfect, but he was the master-spirit in the society among which he lived, and he exercised a powerful influence in laying the foundations of the state of Vermont. He was a sincere friend of his country, and did much in behalf of the revolution. When applied to by the rebel Shays, to become the leader of the insurrection in 1786, he rejected the proffer with indignation.

Allen was a man of great determination, and, living in the midst of turmoil, was somewhat reckless in his temper. While he held a military command, during the revolution, a notorious spy was taken and brought to his quarters. Allen immediately sentenced him to be hung at the end of two or three days, and arrangements were accordingly made for the execution. At the appointed time, a large concourse of people had collected around the gallows, to witness the hanging. In the mean time, however, it had been intimated to Allen that it was necessary to have a regular trial of the spy.

This was so obvious, that he felt compelled to postpone the execution of the culprit. Irritated, however, at this delay of justice, he proceeded to the gallows, and, mounting the scaffold, harangued the assembly somewhat as follows: " I know, my friends, you have all come here to see Rowley hanged, and, no doubt, you will be greatly disappointed to learn that the performances can't take place to-day. Your

disappointment cannot be greater than mine, and I now declare that if you'll come here a fortnight from this day, Rowley shall be hung, or I will be hung myself."

The rude state of society in which Allen spent the greater part of his life was little calculated to polish his manners. Being at Philadelphia, before the election of General Washington as president, he was invited to dinner, by the general upon an occasion of some ceremony. He took his seat by the side of Mrs. Washington, and in the course of the meal, seeing some Spanish olives before him, he took one of them, and put it in his mouth. It was the first he had ever tasted, and, of course, his palate revolted. "With your leave, ma'am," said he, turning to Lady Washington, "I 'll take this plaguy thing out of my mouth."

When Allen was in England, a prisoner, persons who had heard him represented as a giant in stature, and scarcely short of a cannibal in habits and disposition, came to see him, and gazed at him with mingled wonder and disgust. It is said, that, on one occasion, a tenpenny nail was thrown in to him, as if he were a wild animal. He is reported to have picked it up, and, in his vexation, to have bitten it in two. It is in allusion to this that Doctor Hopkins wrote,—

> "Lo, Allen 'scaped from British jails,
> His tushes broke by biting nails," &c.

But however rude were Allen's manners, he was a man of inflexible integrity. He was sued, upon a certain occasion, for a note of hand, which was wit-

nessed by an individual residing at Boston. When the case came on for trial in one of the Vermont courts, the lawyer whom Allen had employed to manage it so as to get time, rose, and, for the purpose of securing this object, pleaded a denial of the signature.

It chanced that Allen was in the court-house at this moment, and hearing this plea, he strode across the court-room, and, while his eyes flashed with indignation, he spoke to the court as follows: "May it please your honors, that 's a lie! I say I did sign that note, and I did n't employ Lawyer C * * * * * * to come here and tell a falsehood. That 's a genuine note, and I signed it, please your honors, and I mean to pay it; all I want is to put it over till next court, when I expect to have money enough to meet it!" This speech gratified the opposing counsel so much, that he immediately consented to the delay which Allen desired.

Though Allen's education was limited, by reading and reflection he had acquired a considerable amount of knowledge. Presuming upon this, and guided by the eccentricity which marked his character, he ventured to assail the Christian religion, in a book entitled, "The Oracles of Reason." Though he here expressed belief in a God, and a future state of rewards and punishments, he rejected the Bible, and seemed to favor the Pythagorian doctrine of transmigration of souls. He entertained the idea that he was himself destined to reappear on earth in the condition of a great white horse! These absurdities show into what depths of folly a great man may be led, if he permit his self-conceit to involve him in the discussion of subjects beyond his grasp.

DAVID CROCKETT.

This individual was one of those remarkable characters, formed by the rough and adventurous circumstances of western life. His paternal grandfather and grandmother, who were of Irish descent, were murdered by the Creek Indians, in Tennessee. He had an uncle who was wounded at the same time, and remained in captivity with the savages for seventeen months. The subject of our memoir was born in 1786, on the banks of Nola-chucky river, he being the fifth son.

At this period, Tennessee was nearly a wilderness, and the forests were still, to a great extent, the dominion of the Indian and the wild beast. Brought up in this condition, his youthful imagination tinged by the tragic story of his ancestors, it was natural that our young hero should have become an early lover of those wild enterprises and hazardous adventures which belong to border life.

In the memoir with which Crockett has favored us, he gives an account of many events, some of which are not a little marvellous, though we have no reason to doubt their truth. The following will serve as a specimen of his style, as well as of the circumstances which attended his childhood. "Joseph Hawkins,

who was a brother to my mother, was in the woods hunting for deer. He was passing near a thicket of brush, in which one of our neighbors was gathering some grapes, as it was in the fall of the year, and the grape season. The body of the man was hid by the brush, and it was only as he would raise his hand to pull the bunches, that any part of him could be seen. It was a likely place for deer; and my uncle, having no suspicion that it was any human being, but supposing the raising of the hand to be the occasional twitch of a deer's ear, fired at the lump, and as the devil would have it, unfortunately shot the man through the body. I saw my father draw a silk handkerchief through the bullet hole, and entirely through his body; yet, after a little while, he got well, as little as any one would have thought it. What became of him, or whether he is dead or alive, I don't know; but I reckon he didn't fancy the business of gathering grapes in an out-of-the-way thicket again."

When David was about eight years old, his father settled in Jefferson county, Tennessee, and opened a small tavern, chiefly for wagoners. He was poor, and his son says, "Here I remained with him, till I was twelve years old. About that time, you may *guess*, if you are a yankee, and *reckon*, if, like me, you belong to the backwoods, that I began to make my acquaintance with hard times, and plenty of them."

At this period, an old Dutchman, who was proceeding to Rockbridge, a distance of four hundred miles, stopped over night at his father's house. He had a large stock of cattle, and needing assistance, David was hired by him, and proceeded on foot the whole of

the journey. He was expected to continue with the Dutchman, but his love of home mastered him, and taking his clothes in a bundle on his back, he stole away one night, and begged his way among the straggling settlements, till he reached his father's residence.

David was now sent to school; but at the end of four days he had a quarrel with one of his mates, and having scratched his face badly, he did not dare to go again. He therefore spent several days in the woods, during school hours, leaving his father to suppose he was at his lessons. When he found out, from the master, what David had done, he cut a hickory stick, and approached him in great wrath, intending to chastise him severely. The boy saw the danger, and fled. It was a tight race, but youth had the advantage. David escaped, hid himself in the woods for a time, and then, bidding adieu to his home, set forth upon his adventures.

Passing through a great variety of conditions, he at last reached Baltimore, and for the first time looked forth upon the blue ocean and the ships that navigate it. He had heard of these things, but he tells us, that until he actually saw them, he did not in his heart believe in their existence. It seems that his first sight of the sea excited in his bosom those deep, yet indescribable emotions, known only to those who have had experience like his own.

He set out at length to return to his father's house; but, owing to a variety of causes, it was three years before he reached it. It was evening when he came to the tavern, and he concluded to ask for lodging,

and not make himself known, till he saw how the land lay. He gives an account of what followed, in these terms:—

"After a while, we were all called to supper: I went with the rest. We sat down to the table, and began to eat, when my eldest sister recollected me: she sprung up, ran and seized me around the neck, and exclaimed, 'Here is my lost brother!'

"My feelings at this time it would be vain and foolish for me to attempt to describe. I had often thought I felt before, and I suppose I had; but sure I am, I never had felt as I then did. The joy of my sisters, and my mother, and indeed of all the family, was such that it humbled me, and made me sorry that I hadn't submitted to a hundred whippings, sooner than cause so much affliction as they had suffered on my account. I found the family had never heard a word of me from the time my brother left me. I was now almost fifteen years old, and my increased age and size, together with the joy of my father, occasioned by my unexpected return, I was sure would secure me against my long-dreaded whipping; and so they did. But it will be a source of astonishment to many, who reflect that I am now a member of the American Congress—the most enlightened body of men in the world—that at so advanced an age, the age of fifteen, I did not know the first letter in the book."

The following passage, continuing the narrative, evinces sense and feeling, which are honorable to our hero's head and heart. "I had remained for some short time at home with my father, when he informed

me that he owed a man, whose name was Abraham Wilson, the sum of thirty-six dollars; and that if I would set in and work out the note, so as to lift it for him, he would discharge me from his service, and I might go free. I agreed to do this, and went immediately to the man who held my father's note, and contracted with him to work six months for it. I set in, and worked with all my might, not losing a single day in the six months. When my time was out, I got my father's note, and then declined working with the man any longer, though he wanted to hire me mighty bad. The reason was, it was a place where a heap of bad company met to drink and gamble, and I wanted to get away from them, for I knowed very well if I staid there I should get a bad name, as nobody could be respectable that would live there. I therefore returned to my father, and gave him up his paper, which seemed to please him mightily, for, though he was poor, he was an honest man, and always tried mighty hard to pay off his debts.

"I next went to the house of an honest old Quaker, by the name of John Kennedy, who had removed from North Carolina, and proposed to hire myself to him, at two shillings a day. He agreed to take me a week on trial, at the end of which he appeared pleased with my work, and informed me that he held a note on my father for forty dollars, and that he would give me that note if I would work for him six months. I was certain enough that I should never get any part of the note; but then I remembered it was my father that owed it, and I concluded it was my duty, as a child, to help him along, and ease his lot as much

as I could. I told the Quaker I would take him up at his offer, and immediately went to work. I never visited my father's house during the whole of this engagement, though he lived only fifteen miles off. But when it was finished, and I had got the note, I borrowed one of my employer's horses, and, on a Sunday evening, went to pay my parents a visit. Some time after I got there, I pulled out the note, and handed it to my father, who supposed Mr. Kennedy had sent it for collection. The old man looked mighty sorry, and said to me he had not the money to pay it, and did n't know what he should do. I then told him I had paid it for him, and it was then his own; that it was not presented for collection, but as a present from me. At this, he shed a heap of tears; and as soon as he got a little over it, he said he was sorry he could n't give me anything, but he was not able, he was too poor."

David continued to work for the Quaker, during which time he became enamored of a girl in the vicinity, and when he was eighteen he engaged to marry her; she, however, proved faithless, and wedded another man. The youth took it much to heart, and observes, "I now began to think that in making me, it was entirely forgotten to make my mate; that I was born odd, and should always remain so." He, however, recovered, and paid his addresses to a little girl of the neighborhood, whom he met one day when he had got lost in the woods, and married her. She had for her marriage portion two cows and two calves; and, with fifteen dollars' worth of furniture, they commenced house-keeping. He rented a small farm, and

went to work. After a few years, he removed to another part of the state, where there was plenty of game, in consequence of which he became a hunter. About the year 1810, he settled on Bear Creek, where he remained till after the war of 1812.

During the Creek war in Tennessee, in 1812, Crockett served as a private soldier under General Jackson, and displayed no small share of enterprise and daring. He also served in one of the expeditions to Florida, meeting with a great variety of adventures. Soon after the close of the war, in 1815, he lost his wife, but married again, and, as he says, "went ahead."

After a time, he removed, with his family, to Shoal Creek, where the settlers, living apart from the rest of the world, set up a government for themselves; they established certain laws, and Crockett was elected one of the magistrates. The operations of this forest republic are thus described by our hero:—

"When a man owed a debt, and wouldn't pay it, I and my constable ordered our warrant, and then he would take the man, and bring him before me for trial. I would give judgment against him, and then an order for an execution would easily scare the debt out of him. If any one was charged with marking his neighbor's hogs, or with stealing anything,—which happened pretty often in those days,—I would have him taken, and if there was tolerable grounds for the charge, I would have him well whipped, and cleared. We kept this up till our legislature added us to the white settlements in Giles county, and appointed magistrates by law, to organize matters in the parts where

I lived. They appointed every man a magistrate who had belonged to our corporation. I was then, of course, made a squire according to law, though now the honor rested more heavily on me than before. For, at first, whenever I told my constable, says I,—'Catch that fellow, and bring him up for trial,' away he went; and the fellow must come, dead or alive; for we considered this a good warrant, though it was only in verbal writings. But after I was appointed by the assembly, they told me my warrants must be in real writing, and signed; and that I must keep a book, and write my proceedings in it. This was a hard business on me, for I could just barely write my own name."

Crockett now rose rapidly; he was elected a colonel in the militia, and, by request of his friends, became a candidate for the state legislature. He made an electioneering tour of nearly three months, addressing the voters at various points. His account of this part of his life is full of wit, and not only throws much light upon western manners, but suggests many keen and sagacious reflections upon the character and conduct of political leaders, seeking the suffrages of the people. His success upon the stump was great, though he confesses he knew nothing about government, and dared not even touch the subject. He told droll stories, however, which answered a better purpose, and in the result, was triumphantly elected. We must not omit to give Crockett's own account of himself at this period.

"A short time after this," says he, "I was in Pulaski, where I met with Colonel Polk, now a member

A GLANCE AT THE SCIENCES.

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A GLANCE AT THE PHYSICAL SCIENCES; OR THE WONDERS OF NATURE, IN EARTH, AIR, AND SKY:

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A GLANCE AT THE SCIENCES.

INTRODUCTION.

NATURAL OR PHYSICAL SCIENCE is as boundless in its scope as the extent of the universe. It does not confine its researches to the narrow circle within our own observation: it is not content with the investigation of objects presented to the naked eye: it goes with the telescope into the heavens, and descends with the microscope into the atom — every where discovering materials for its consideration. Nor is it absorbed with observations upon the forms and hues of material objects: it seeks out the hidden laws of the universe, the principles by which the Architect of the earth and heavens constructs and governs his boundless dominions.

We are apt to wrap up the true idea of scientific investigations in a bald and chilling phraseology: we call them *studies of nature;* but they are, in truth, studies into the ways of God. What is *nature*, separate from that active and intelligent Being to whom

we are indebted for life and light, — that Being who gave us the Bible as well as the Sun, and is as truly the moral as he is the natural Governor of the universe?

The true mode of pursuing scientific studies is to regard them as investigations into the works of the Almighty, and every where, as well in the contemplation of the starry firmament as in scrutinizing the more familiar objects of our own globe, to realize the presence of the Creator. In this way, science unseals the volume of Nature's revelation, to the most noble and exalting purposes.

"While the telescope," says Dr. Chalmers, "enables us to see a system in every star, the microscope unfolds to us a world in every atom. The one instructs us that this mighty globe, with the whole burden of its people and its countries, is but a grain of sand in the vast field of immensity: the other, that every atom may harbor the tribes and families of a busy population. The one shows us the insignificance of the world we inhabit: the other redeems it from all its insignificance; for it tells us that, in the leaves of every forest, in the flowers of every garden, in the waters of every rivulet, there are worlds teeming with life, and numberless as are the stars of the firmament. The one suggests to us that, above and beyond all that is visible to man, there may be regions of creation which sweep immeasurably along, and carry the impress of the Almighty's hand to the remotest scenes of the universe;

the other that, within and beneath all that minuteness which the aided eye of man has been able to explore, there may be a world of invisible beings; and that, could we draw aside the mysterious curtain which shrouds it from our senses, we might behold a theatre of as many wonders as astronomy can unfold; a universe within the compass of a point, so small as to elude all the powers of the microscope, but where the Almighty Ruler of all things finds room for the exercise of His attributes, where He can raise another mechanism of worlds, and fill and animate them with all the evidence of His glory."

How interesting, how instructive, is science, while we thus walk its paths in the light of God's image, and with the constant assurance that, while He thus pursues His vast operations, He is still presiding over the beating of our hearts, and that not even the sparrow falls unnoticed to the ground! How comparatively barren and desolate are the works of creation, if the Christian's God is every where invisible, and the whole phenomena of nature are to be resolved into an inscrutable series of causes and consequences!

In the course of the following pages, we propose only to present a rapid and distinct outline of *Physical Science*, as it is now exhibited in the works of learned men. Within the present century, the march of knowledge has been rapid beyond example, and at the same time, the most wonderful discoveries have been

brought within the reach of every reader. Philosophy is no longer sealed up in learned languages, and kept under the lock and key of colleges and universities. In the compass of this little volume, we hope to place within the reach of our readers, not only the most important results of the researches of Herschel and Laplace into the mechanism of the heavens, but of those of Lyell, Mantel, and others, into the structure of our earth; to present the wonders of the telescope and the microscope; in short, to open the book of natural philosophy, and take a glance at its wonderful revelations, in respect to the stars above, and the animal, vegetable, and mineral kingdoms here below.

ASTRONOMY.

"ASTRONOMY is that department of knowledge which has for its object to investigate the motions, the magnitudes, and distances, of the heavenly bodies; the laws by which their movements are directed, and the ends they are intended to subserve in the fabric of the universe. This is a science which has in all ages engaged the attention of the poet, the philosopher, and the divine, and been the subject of their study and admiration. Kings have descended from their thrones to render it homage, and have sometimes enriched it with their labors; and humble shepherds, while watching

their flocks by night, have beheld with rapture the blue vault of heaven, with its thousand shining orbs, moving in silent grandeur, till the morning star announced the approach of day. The study of this science must have been coeval with the existence of man; for there is no rational being who has for the first time lifted his eyes to the nocturnal sky, and beheld the moon walking in brightness amid the planetary orbs and the host of stars, but must have been struck with admiration and wonder at the splendid scene, and excited to inquiries into the nature and destination of those far-distant orbs. Compared with the splendor, the amplitude, the august motions, and the ideas of infinity which the celestial vault presents, the most resplendent terrestrial scenes sink into inanity, and appear unworthy of being set in competition with the glories of the sky.

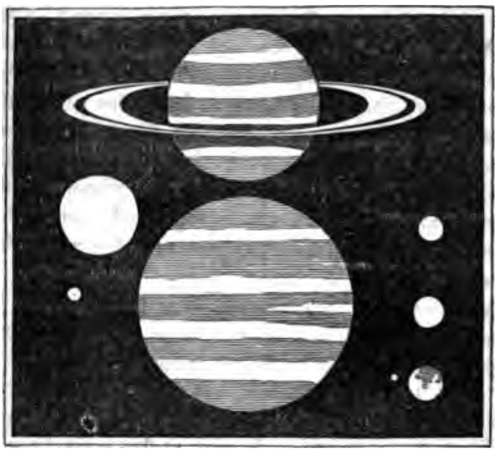
"When, on a clear autumnal evening, after sunset, we take a serious and attentive view of the celestial canopy; when we behold the moon displaying her brilliant crescent in the western sky; the evening star gilding the shades of night; the planets moving in their several orbits; the stars, one after another, emerging from the blue ethereal, and gradually lighting up the firmament till it appears all over spangled with a brilliant assemblage of shining orbs; and particularly when we behold one cluster of stars gradually descending below the *western* horizon, and other clusters emerging from the *east*, and ascending, in unison, the canopy of heaven; when we contemplate the whole celestial vault, with all the shining orbs it contains, moving in silent grandeur, like one vast concave sphere, around this lower world and the place on which we stand — such a

scene naturally leads a reflecting mind to such inquiries as these: Whence come those stars which are ascending from the east? Whither have those gone which have disappeared in the west? What becomes of the stars, during the day, which are seen in the night? Is the motion which appears in the celestial vault *real*, or does a motion in the Earth itself cause this appearance? What are those immense numbers of shining orbs which appear in every part of the sky? Are they mere studs, or tapers, fixed in the arch of heaven, or are they bodies of immense size and splendor? Do they shine with borrowed light, or with their own native lustre? Are they placed only a few miles above the region of the clouds, or at immense distances, beyond the range of human comprehension? Can their distance be ascertained? Can their bulk be computed? By what laws are their motions regulated — and what purposes are they destined to subserve in the great plan of the universe?"

These, and similar questions, it is the province of *Astronomy* to resolve, so far as human intelligence can compass them. Vast as is the subject, and far as it may seem beyond our reach, yet in no other science have there been such gradual and constant accessions of knowledge as in this. It may at the same time be observed, that in none so much remains to be discovered. Laplace, who knew more than any other man of the mechanism of the heavens, said earnestly, on his deathbed, "What we know is little — what we do not know is immense." The same feeling was entertained by Newton, at the moment of his immortal discovery of the principle of gravitation, when,

with the modesty of all great minds, beside whose infinite aspirations the highest possible attainment is ever insignificant, he exclaimed, "I am but as a child standing upon the shore of the vast, undiscovered ocean, and playing with a little pebble, which the waters have washed to my feet."

THE SOLAR SYSTEM.



Comparative Size of the larger Planets.

The Solar System is composed of a great central luminary, the Sun, whose mass is supposed to be made up of opaque matter, like the Earth,— the atmosphere alone being luminous,— and a number of comparatively small engirdling bodies, the planets, comets, &c., which revolve around it in various periods. The comparative

size of these bodies, and their respective distances from each other, may be estimated by the following illustration. On a level field, place a globe, two feet in diameter; this will represent the SUN. MERCURY will be represented by a grain of mustard seed, on the circumference of a circle 164 feet in diameter; VENUS, by a pea, on a circle 284 feet in diameter; the EARTH, a somewhat larger pea, on a circle of 430 feet; MARS, a large pin's head, on a circle of 654 feet; JUNO, CERES, VESTA, and PALLAS, grains of sand, in orbits of from 1000 to 1200 feet; JUPITER, an orange, in an orbit of nearly half a mile across; SATURN, a small orange, in an orbit of four fifths of a mile; and URANUS, a cherry, on the circumference of a circle more than a mile and a half in diameter. We shall now proceed to give a more particular account of these members of the solar system.

THE SUN.

The Sun, when viewed with a telescope, presents the appearance of an enormous globe of fire, frequently in a state of violent agitation or ebullition. Black spots, of irregular form, rarely visible to the naked eye, sometimes pass over his disk, in a space of about fourteen days; one was measured by Sir W. Herschel, in 1779, and found to be 30,000 miles in breadth. A spot, when first seen on the eastern edge, appears like a line, progressively extending in breadth, till it reaches the middle, when it begins to contract, and ultimately disappears at the western edge. In some rare instances, spots reappear on the eastern side, and are even permanent for two or three revolutions; but they generally change their aspect in a few days, and disappear.

Astronomers inform us, that sometimes 50 spots are seen, at once, on the Sun's surface. From 1611 to 1629, it was hardly free from spots; while from 1650 to 1670, scarcely any were to be seen. The same irregularity has been frequently noticed. In October, 1827, 150 spots were noticed at one time.

Sometimes, several small spots unite into a large one; again, a large one separates into smaller ones, which soon vanish. These phenomena induced Herschel to suppose the Sun to be a solid, dark nucleus, surrounded by a vast atmosphere, almost always filled with luminous clouds, occasionally opening and disclosing the opaque mass within.

The speculations of Laplace were different; he imagined the solar orb to be a mass of fire, and that the violent effervescences and explosions, seen on its surface, are occasioned by the eruption of elastic fluids formed in its interior; and that the spots are enormous caverns, like the craters of our volcanoes. The theory of Herschel, however, is that most generally received by learned men.

"The *magnitude* of this vast luminary is an object which overpowers the imagination. Its diameter is 880,000 miles; its circumference, 2,764,600 miles; its surface contains 2,432,800,000,000 of square miles, which is twelve thousand three hundred and fifty times the area of the terraqueous globe, and nearly fifty thousand times the extent of all the habitable parts of the Earth. Were its centre placed over the Earth, it would fill the whole orbit of the moon, and reach 200,000 miles beyond it on every hand. Were a person to travel along the surface of the Sun, so as to pass along

every square mile on its surface, at the rate of thirty miles every day, it would require more than two hundred and twenty millions of years before the survey of this vast globe could be completed.

"It would contain within its circumference more than thirteen hundred thousand globes as large as the Earth, and a thousand globes of the size of Jupiter, which is the largest planet of the system. It is more than five hundred times larger than all the planets, satellites, and comets belonging to our system, vast and extensive as some of them are. Although its density is little more than that of water, it would weigh 3360 planets such as Saturn, 1067 planets such as Jupiter, 329,000 globes such as the Earth, and more than 2,000,000 of globes such as Mercury, although its density is nearly equal to that of lead."

The most obvious *apparent* motion of the Sun is, that it seems to rise in the morning in the east; to traverse the heavens in a westerly direction, and at last to disappear beneath the horizon. But it is now well understood that the Sun is quiescent, and that the seeming motion we have described is occasioned by the daily rotation of the Earth on its axis. But although the Sun stands in the centre of the system of planets, it appears that it revolves on its axis like the other heavenly bodies, and that it completes its revolution in twenty-five days and ten hours. Every part of its equator moves at the rate of 4352 miles an hour. It is also considered probable that the Sun, attended by its troop of planets, makes a vast journey in space, but whether in a straight line, or in an immense circle, is still matter of conjecture.

THE PLANET MERCURY.

This planet is 37,000,000 miles from the Sun, and is the nearest that has yet been discovered. It is seldom seen by the naked eye; its daily revolution is performed in 24 hours, 5 minutes, and 20 seconds. It revolves round the Sun in the space of 87 days and 23 hours. When viewed with the telescope, it presents the various phases of the moon, from a crescent to the full, round orb.

Few discoveries have been made on this planet, owing to the dazzling splendor of its rays. Mountains, however, have been seen; and one of them is said to be upwards of ten miles in height, which is nearly twice the elevation of the loftiest peaks on our globe. The light upon its surface is supposed to be seven times greater than upon the Earth. If the planet be inhabited, it is obvious that the organization of the eye must be different from that of ours. It is supposed that the intensity of heat is not greater than with us.

The diameter of Mercury is 3200 miles. Its surface contains 32,000,000 of square miles. It is about one fifteenth the size of the Earth.

In its revolution round the Sun, its motion is swifter than that of any other planet, being 109,800 miles every hour, 1830 miles every minute, and more than 30 miles during each beat of the pulse. The density of matter composing Mercury is twice that of the Earth, yet it would require two millions of globes, of the same size, to make one of the size and density of the Sun.

THE PLANET VENUS.

With the exception of the Sun and moon, this is the most splendid of the heavenly bodies. It appears like a shining lamp amid the lesser orbs of night; and, at particular seasons, ushers in the morning dawn and the evening twilight. But if such is its appearance to the naked eye, it becomes a still more interesting object, when viewed with the telescope of the astronomer. It passes through all the phases of the moon, from the crescent to the gibbous form; and formerly several dark spots were noticed upon its surface. Its daily rotation is performed in 23 hours and 20 minutes. Several mountains have been discovered, and one of them is nearly twenty miles high, or five times the height of Chimborazo. It possesses an atmosphere supposed to be about three miles in height, and is supposed to have a satellite, or moon; but this is not determined with certainty.

The diameter of Venus is 7800 miles, being a little less than that of the Earth. It does not appear that any great quantity of water exists upon it. Its quantity of light is about twice that of the Earth. It revolves in an orbit of 433,800,000 miles, in the space of 224 days and 16 hours. Its distance from the Sun is 68,000,000 miles, and from the Earth, when nearest to us, about 27,000,000 miles. Its matter is in a slight degree less dense than that of the Earth.

THE EARTH.

Although the Earth appears to be larger than all the heavenly orbs, it is, in fact, infinitely smaller, and holds

a rank with the inferior bodies of the universe. Although it appears to the eye of sense immovably fixed, it has a double motion — one on its own axis, and one around the Sun, by which it is transported, with all its continents, and oceans, and kingdoms, at the rate of more than a thousand miles a minute.

This planet, like all the other heavenly bodies, has a globular shape; but it is not a perfect globe, it being depressed at the poles. The diameter, through the poles, is 34 miles less than through the equator. This curious fact was discovered by perceiving that the pendulum of a clock had 140 vibrations less in a day, at Paris, than at Cayenne, in Guiana. Further observations were made, and it was found that this variation was uniform, and that the vibrations regularly diminished in proceeding northward from the equator. This led to many curious investigations, which resulted in demonstrating

the fact we have above mentioned. It is interesting to observe, that so simple a circumstance as the slower movement of clocks, in a southern latitude, should have led to so wonderful a discovery in science as the depression of the poles of the Earth.

The prominent feature of the Earth's surface is its division into land and water; the latter predominates, occupying 148,000,000 square miles, or more than two thirds of the face of the globe. It contains 296,000,000 of cubical miles of water, sufficient to cover the whole globe to the depth of more than half a mile. This superabundance of water is probably peculiar to our planet, and is conjectured to have resulted from the deluge.

The surface of the Earth is further diversified by ranges of mountains, stretching across the continents and islands, and giving variety to the landscapes of every country. From these mountains flow myriads of streams, fertilizing the valleys through which they take their course, and at last losing themselves in the ocean. An atmosphere, about 100 miles in height, surrounds this terraqueous mass, which, put in motion, forms the winds, which fan the earth with gentle breezes, or heave the ocean into billows. It is the theatre where the lightnings flash, and the thunders roll; where the meteor sweeps with its fiery train, and the Aurora Borealis displays its fantastic coruscations.

Were the Earth viewed from some point in the heavens — as the moon, for instance — it would have somewhat the same appearance as the moon does to us. The distinction between its seas, oceans, continents,

and islands, would be clearly marked, and would appear like brighter or darker spots upon its disk. The continents would appear bright, and the oceans of a darker hue, because water absorbs a great part of the solar rays that fall upon it.

The Earth, as it would appear from the Moon.

We are quite well acquainted with the surface of the Earth, but our knowledge of its internal structure is very limited. The deepest mine does not extend more than a mile from the surface; and this depth, compared with the diameter of the Earth, is not more than the scratch of a pin upon the surface of an artificial globe. What materials are to be found within the bowels of the Earth, will be forever beyond the power of mortals to determine. It is supposed, however, and not without reason, that, while the crust of the globe consists of

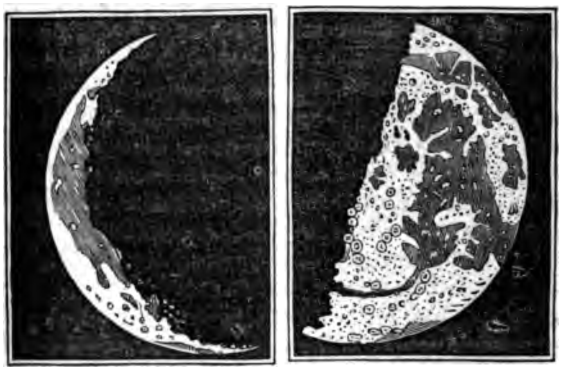
a framework of rocks, mingled with earth and water, the centre is occupied with a vast metallic mass in a state of fusion from heat.

The density of the whole Earth, bulk for bulk, is estimated at five times the weight of water, so that it would counterpoise five globes of water of the same size. The diurnal revolution of the Earth is performed in 23 hours, 56 minutes. This gives rise to day and night; to which arrangement of nature, the economy of the vegetable as well as of the animal world is adjusted. The annual revolution of the Earth is accomplished in 365 days, 5 hours, 45 minutes, and 51 seconds. From this proceed the varieties of the seasons: spring, summer, autumn, and winter, follow each other in constant succession, diversifying the scenery of nature, and marking the different periods of the year. In those countries which lie in the southern hemisphere of the globe, as at Buenos Ayres and the Cape of Good Hope, December, January, and February, are the summer months, while in this northern hemisphere, these are the winter months, when the weather is coldest and the days are shortest.

The average distance of the Earth from the Sun is 95,000,000 miles. The length of the path annually travelled by the Earth in its orbit is 567,019,740 miles, or about 1000 miles a minute, or 17 miles a second.

The *Moon*, a satellite of our own planet, is the heavenly body of which we have the most accurate knowledge. Its surface exhibits a very large number of mountains, almost uniformly of a circular or cusp-shaped form, the larger ones having, for the most part, flat bottoms within, from which rises, in the

centre, a small, steep, conical hill. They offer, in its highest perfection, the true volcanic character, as it may be seen in the crater of Vesuvius. In some of the principal ones, decided marks of volcanic stratification, arising from successive deposits of ejected matter, may be clearly traced with powerful telescopes.



Telescopic Views of the Moon.

It is, moreover, a singular fact in the geology of the moon, that, although nothing like water can be perceived, yet there are large regions perfectly level, and apparently of an alluvial character. The mountains are known by their shadows, which are distinctly visible, and which are long when they are near the boundary of light and darkness, or when the sun is in the horizon, and disappear when they are 90 degrees from that boundary, or when the sun is overhead.

The moon is generally believed either to have no atmosphere, or one of such tenuity as not to equal in

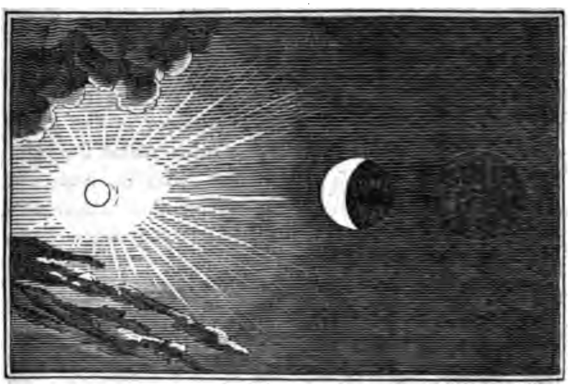
density the contents of an exhausted receiver. From this it has been inferred that there are no fluids at the surface of the moon — since, if there were, an atmosphere must be formed by evaporation. Without air and water, it would seem that the moon cannot be inhabited ; or, if life exist there, it cannot be in any form which is exhibited in our own planet. The days and nights in the moon are each 14 days and three quarters in length: the intense heat and cold which must thus alternate would destroy human life, even on the supposition that vegetation could be maintained.*

The moon, like all other heavenly bodies, appears to rise in the east and set in the western part of the horizon. Its real motion, however, is in a contrary direction — that is, from west to east, or in the same direction in which all the planets move round the Sun. It is a dark body, deriving its light from the Sun, and occasionally a faint light, by reflection of the Sun's rays, from the Earth. It is about 240,000 miles from the centre of the Earth, and pursues its course around this planet at the rate of 2300 miles an hour. It

* Such are the conclusions of most philosophers. Yet Dr. Dick observes, that "probably the moon is surrounded with a fluid which serves the purpose of an atmosphere, though it may be different in its nature and composition from that which surrounds the earth." He hence concludes that the moon may be inhabited, and, indeed, proceeds to assume this as the fact. Upon this, he makes a great variety of ingenious suggestions, and even supposes it to be possible to trace the operations of intelligent beings upon its surface. Dr. Olbers is also of the opinion, that the moon is inhabited by rational creatures, and that its surface is covered with vegetation not very dissimilar to that of our Earth.

performs its revolution in 29 days, 12 hours, and 44 minutes. It is a curious fact, that the revolution on its axis is performed in the same time as its revolution round the Earth. Accordingly, it always presents the same face to the Earth, so that we never see more than one side of it.

The moon appears nearly as large as the Sun; but it is but about one fiftieth the size of the Earth, and it would take 63,000,000 of globes, of the size of the moon, to make one of the Sun.

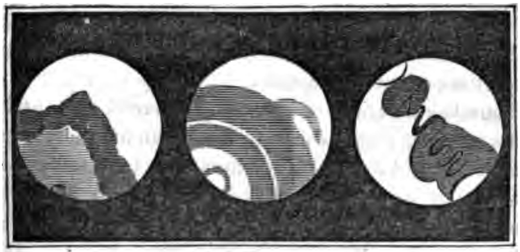


An Eclipse of the Sun.

When the Earth comes between the Sun and moon, it casts its shadow upon the latter, which is then said to be eclipsed. An eclipse of the Sun is occasioned by the moon coming between the Earth and the Sun, thus cutting off its rays. An eclipse of the moon always occurs at the time of its full; eclipses of the Sun occur at the time of the new moon. It is one of the

triumphs of science, that these sublime phenomena, formerly so fruitful a source of superstitious fear and ominous prediction, are now the subject of the most exact calculation, and are as much divested of every mysterious attribute, as the common events of sunrise and sunset.

THE PLANET MARS.



Telescopic Appearances of Mars.

The Earth is placed, in the solar system, between the orbits of Venus and Mars. The latter is 145,000,000 miles from the Sun. When nearest the Earth, its distance is 50,000,000; when farthest, 240,000,000 miles. This fact will explain, what most persons have noticed, that this planet is at one time almost imperceptible, and at another seems to vie with Jupiter in magnitude and splendor. The diurnal revolution of Mars is performed in 24 hours, 39 minutes, 29 seconds. Its orbit is 900,000,000 miles in circumference. It performs this circuit in 1 year and 322 days. Its rate of motion is 54,649 miles every hour, which is more than a hundred times greater than the utmost velocity of a cannon-ball.

When viewed through a telescope, this planet pre-

sents a variety of dark spots and belts, though of different forms and shades. Luminous spots, and zones, have also been discovered, which frequently change their appearance, and alternately disappear and return. The latter are supposed to be occasioned by snow; the former are conjectured to be occasioned by a distribution of the face of the planet into land and water. It is supposed that one third of the surface is occupied by the latter. It is probable that the diversities in the appearance of Mars, as seen through a telescope, are in part occasioned by clouds.

Mars has a variety of seasons, similar to ours, and it bears a closer resemblance to the Earth than any other planet. It is 4200 miles in diameter, a little more than half that of our globe. No moon or satellite has been discovered, as attendant upon it.

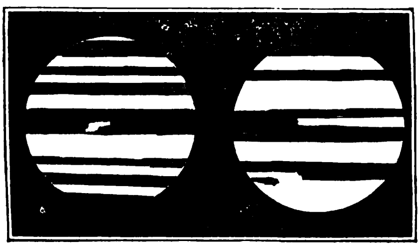
CERES, PALLAS, JUNO, AND VESTA.

The immense interval which lies between the orbits of Mars and Jupiter had led the astronomers to surmise that some planet, of considerable magnitude, might possibly exist within this limit. But instead of one, four small orbs have been recently discovered, which bear the above names. The first, called Ceres, was discovered by Piazzi, in Sicily, on the first day of the present century. Pallas was discovered in March, 1802, by Olbers; Juno by Harding, in September, 1804, and Vesta by Olbers, in March, 1807.

These four planets are invisible to the naked eye, and we are, therefore, indebted to the telescope for a knowledge of their existence. It is conjectured, and not without reason, that these four planets were once

united in one, and that by some mighty force they have been sundered, and thrown into their present orbits. Their diameter has not been ascertained with precision. Herschel reckons that the largest does not exceed 500 miles in circumference. In several respects, they are marked with peculiarities. The orbits of some of them cross each other, which is not the case with any other planet. They revolve in nearly the same mean distances from the Sun,—that is, about 260,000,000 miles. Their annual revolutions, also, are nearly the same; being little more than four years. They are smaller than the other planets—Ceres containing but one eighth part as many solid miles as Mercury. It is probable that they are even smaller than the moons of Jupiter, Saturn, or Uranus.

THE PLANET JUPITER.



Telescopic Views of Jupiter.

We now come to one of the most splendid orbs in the planetary system. Jupiter is 495,000,000 miles from the Sun, and the circumference of its orbit is 3,110,000,000 of miles. Around this orbit it moves in 11 years, 315 days, at the rate of about 30,000 miles

an hour. Its nearest approach to the Earth is about 600,000,000 miles. A cannon-ball, flying at the rate of 500 miles an hour, would reach it in a little less than a hundred years. The daily rotation of Jupiter is performed in 9 hours, 59 minutes, 49½ seconds. Its circumference is 278,600 miles. Its density is a little more than that of water, or five times less than that of the Earth. It is the largest planet in our system, being 1400 times larger than the Earth.

When viewed with a powerful telescope, this planet presents a splendid appearance. Its surface, then, seems larger than the full moon to the naked eye. Its disk is diversified with darkish parallel stripes. The four satellites, revolving around the planet, generally appear in a straight line with each other. Sometimes, only two of them are visible, the other two being eclipsed either by the disk or the shadow of Jupiter; at other times, all are seen at once. From their changing appearance, it it supposed that the dark belts of Jupiter are the body of the planet, seen through something analogous to clouds, floating in its atmosphere at a considerable elevation above its surface.

The day and night in Jupiter are nearly equal. The intensity of its solar light is 27 times less than that of the Earth. It is greatly depressed at the poles; the diameter of the equator being 6,300 miles greater than that at the poles.

THE PLANET SATURN.

This planet may be considered in many respects the most magnificent and interesting body within the limits of the planetary system. Taking into view its satellites

and rings, it has a greater quantity of surface than even the globe of Jupiter; and its majestic rings constitute the most singular and astonishing phenomena that have yet been discovered in the sidereal universe.

Its distance from the Sun is 906,000,000 of miles, which is nearly twice the distance of Jupiter, or ten times that of the Earth. The circumference of its orbit is 5,695,000,000 of miles. When nearest, it is 811,000,000 of miles from the Earth. A steam carriage, travelling at the rate of 20 miles an hour, would not reach it in less than 4629 years.

This planet revolves round the Sun in the space of about 29½ years. Its motion is at the rate of 22,000 miles an hour. Its diurnal rotation is performed in 10 hours, 29 minutes, and 17 seconds. This rotation is perpendicular to the plane of its rings. Its proportion of light from the Sun is but one 90th of our own. It is 79,000 miles in diameter, and nearly a thousand times larger than the Earth. When viewed with a telescope, it exhibits belts similar to those of Jupiter, and disposed in lines parallel to the ring. These are permanent, and probably indicate a diversity of surface, either of land or water, or some substance with which we are unacquainted. Its figure is spheroidal, with considerable polar depressions.

The density of Saturn is about the same as cork, or one half that of water. This is taking into view its whole bulk; if its centre is hollow, its exterior parts may be as hard as rock. It has been said, that "while a native of earth could hardly move upon Mercury, from the strong attractive power pulling him to the ground, he could, on the planet Saturn, leap sixty feet

high as easily as he could here leap a yard." These suppositions are, however, unsound. The density of Mercury is double that of the Earth, and nearly that of lead; but it must be considered that the attraction in the planets is somewhat in proportion to the masses of matter which they contain, and not in proportion to their density. Taking this principle into view, the attraction upon the surface of Saturn is a little greater than that of the Earth. It is supposed that there is no planet in the solar system, with the exception of Jupiter, on which an inhabitant of the Earth might not move about as easily as upon our globe; and on Jupiter, he would experience little more than double the weight he now feels.

One of the most astonishing phenomena that have yet been discovered in the heavens, is the double ring of Saturn. As generally observed, we have a side view, in which case it presents nearly the following appearance.

The outside diameter of the exterior ring is 179,000 miles; the outside diameter of the interior ring is 152,000 miles. The breadth of the dark space between the two rings is 1800 miles; so that a body nearly as large as our moon could pass through it. The breadth of the exterior ring is 7200 miles; of the interior, 20,000 miles. The thickness of the ring is

not supposed to be over 100 miles. When it is presented edgewise to the earth, it can only be seen with a powerful glass. This ring is not exactly circular, but slightly elliptical. It is ascertained to have a swift rotation around Saturn, which is completed in about 10 hours and a half. The outer edge of the ring is 550,000 miles in circumference, and moves at the rate of more than 1000 miles a minute.

This double ring is a compact, solid substance, for its shadow is distinctly seen on the planet which it encloses. It is not certain that both parts of the ring have exactly the same periods of rotation. It is about 30,000 miles from the surface of the planet, always keeps the same relative position, and attends it in all its movements. One side of it contains 146 times the surface of the whole of our globe!

These rings will appear, to the inhabitants in the firmament of Saturn, like large luminous circles or semicircles of light, stretching across the heavens from east to west, and occupying one fourth part of the sky. As they are brighter than the body of the planet, it is probable that they are of some substance which is fitted to reflect the solar light with peculiar splendor. How glorious, and diversified, must be the celestial scenery thus presented!

Saturn has seven satellites, all revolving beyond its ring. The nearest is 18,000 miles beyond its exterior edges; the most distant is 2,297,000 miles from the planet, and performs its circuit in about 79½ days. The largest is supposed to be about the size of Mars, or 4200 miles in diameter. These satellites must afford a splendid appearance from the planet, as some of them must seem nine times larger than our moon.

If we take this into view, in connection with the sublime splendor of the rings, it might almost seem that Saturn is fitted up to be the abode of some favored beings, upon whom the Creator has lavished the wonders of his creative power.

THE PLANET URANUS.

This planet, also frequently called after its discoverer, was made known to us by Herschel, who first saw it in March, 1781. Its distance from the Sun is 1,800,000,000 miles; and when nearest the Earth, it is nearly the same distance from us. It moves through its orbit in about 84 years. It is the slowest-moving planet in the system, yet pursues its course at the rate of 1500 miles an hour. It is 110,000 miles in circumference, and 81 times larger than the Earth. Its solar light is 360 times less than ours; yet it is not darker than frequently happens with us in a cloudy day. Its density is nearly equal to that of water. Six satellites are supposed to be connected with this planet; but their periods and other phenomena have not yet been accurately ascertained.

GENERAL REMARKS ON THE PLANETS.

The planets all move from west to east, and nearly in the same plane. They are all opaque bodies, deriving their light from the Sun; they are all spheroidal, approaching the form of an exact globe, with slight unevenness of surface. They have all two motions; one diurnal, around their axes, and one annual, around the Sun. They all present every part of their surface toward the Sun, and they have the alternate change of day and night. They are all connected with the Sun

by the same principle of gravitation. As we know that our Earth is inhabited by thousands of sentient beings, and was created for their accommodation, we may justly conclude that other worlds, associated in the same system, fitted up in nearly the same manner, and acting in obedience to the same great laws, have a similar design, and are, therefore, the abodes of myriads of intelligences not essentially differing from the races on this Earth.

The stupendous scale upon which planets are formed — their mighty masses — their amazing circuits performed in the regions of space — their almost inconceivable velocities — still sink into insignificance, when compared with the enormous bulk of the great central luminary around which they revolve. In order to aid the imagination in its efforts to compass this subject, Dr. Dick makes the following suggestion: —

" There is no point on the surface of the globe that unites so many awful and sublime objects as the top of Etna, and no imagination has dared to form an idea of so glorious and magnificent a scene. The body of the Sun is seen rising from the ocean, immense tracts both of sea and land intervening; the islands of Pinari, Alicudi, Lipari, Stromboli, and Volcano, with their smoking summits, appear under your feet, and you look down on the whole of Sicily as on a map, and can trace every river through all its windings from its source to its mouth. The view is absolutely boundless on every side, so that the sight is every where lost in the immensity.

" Yet this glorious and expansive prospect is comprised within a circle about 240 miles in diameter, and

754 in circumference, containing 45,240 square miles, which is only $\frac{1}{53776608}$ part of the surface of the Sun; so that fifty-three millions, seven hundred and seventy-six thousand landscapes, such as beheld from Mount Etna, must pass before us before we could contemplate a surface as expansive as that of the Sun; and if every such landscape were to occupy two hours in the contemplation, as supposed above, it would require 24,554 years before the whole surface of this immense globe could be in this manner surveyed."

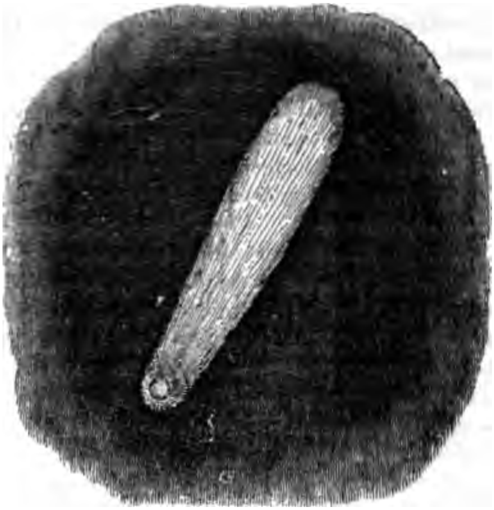
The same writer here quoted, and to whom we are largely indebted in the preparation of this article, says, that "it is owing to the existence of the Sun that our globe is a habitable world, and productive of enjoyment. Almost all the benign agencies which are going forward in the atmosphere, the waters, and the earth, derive their origin from its powerful and perpetual influence. Its light diffuses itself over every region, and produces all that diversity of coloring which enlivens and adorns the landscape of the world, and without which we should be unable to distinguish one object from another. By its vivifying action, vegetables are elaborated from inorganic matter, the sap ascends through their myriads of vessels, the flowers glow with the richest hues, the fruits of autumn are matured, and become, in their turn, the support of animals and of man.

"By its heat, the waters of the rivers and the ocean are attenuated, and carried to the higher regions of the atmosphere, where they circulate in the form of vapor, till they again descend in showers, to supply the sources of the rivers, and to fertilize the soil. By the same agency all winds are produced, which purify the atmos-

phere by keeping it in perpetual motion, which propel our ships across the ocean, dispel noxious vapors, prevent pestilential effluvia, and rid our habitations of a thousand nuisances. By its attractive energy, the tides of the ocean are modified and regulated, the Earth conducted in its annual course, and the moon sustained and directed in her motions. Its influence descends even to the mineral kingdom, and is felt in the chemical compositions and decompositions of the elements of nature.

"The disturbances in the electric equilibrium of the atmosphere, which produce the phenomena of thunder, lightning, and rain, and the varieties of terrestrial magnetism; the slow degradation of the solid constituents of the globe, and their diffusion among the waters of the ocean, may all be traced, either directly or indirectly, to the agency of the Sun. It illuminates and cheers all the inhabitants of the Earth, from the polar regions to the torrid zone. When its rays gild the eastern horizon, after the darkness of the night, something like a new creation appears. The landscape is adorned with a thousand shades and colors; millions of insects awake and bask in its rays; the birds start from their slumbers, and fill the groves with their melody; the flocks and herds express their joy in hoarser acclamations; 'man goeth forth to his work and to his labor;' all nature smiles, and 'the hills rejoice on every side.' Without the influence of this august luminary, a universal gloom would ensue, and surrounding worlds, with all their trains of satellites, would be shrouded in perpetual darkness. This Earth would become a lifeless mass, a dreary waste, a rude lump of inactive matter, without beauty or order."

COMETS.



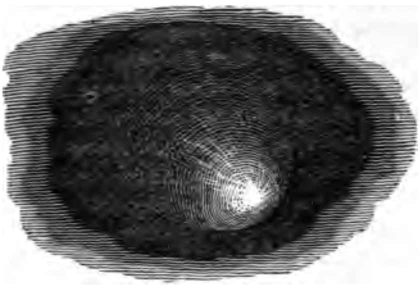
None of the heavenly bodies have been regarded with more interest than the comets, those wandering and mysterious bodies which, in remote ages, were beheld with superstitious terror. They have been imagined to portend war, pestilence, famine, and the death of monarchs; to be the vehicles in which departed souls, released from the care of guardian angels, were transported to heaven; to have been the cause of the deluge; to reënforce the light and heat of the sun; to break up large planets into smaller ones; to change the climate of countries; to introduce epidemic disorders; and, finally, to threaten our globe with total destruction.

A great comet is indeed an object well calculated to impress every beholder with astonishment and awe. Comets have been known with tails extending from the zenith to the horizon, while the disk of the body itself was equal in size to the full moon. The belief which prevailed for a long time with regard to the nature of these bodies, was, that they were meteors of temporary duration, engendered in the atmosphere of the Earth. Some circumstances, certainly, gave a degree of plausibility to this supposition; the suddenness, in many cases, of their appearance and disappearance, the transparency of their tails, and the apparently small density of their bodies. But accurate observations showed that they were far beyond the region of the moon, rendering it clear that they could not be vapors generated in our atmosphere, and giving a strong probability to the opinion maintained of old by the Chaldeans, and supported by Seneca, that they were bodies permanent as the planets of our system, and reappearing at certain intervals, depending on their peculiar orbits.

It is probable that comets are nothing but bodies of gas or vapor, without any solid matter whatever. Stars have been repeatedly seen through their thickest parts. The mechanical effect, therefore, to the Earth, from its collision with a comet, would be no greater than that of a mountain when in contact with a cloud: the result of such a collision would be the mixture of the gaseous matter with the Earth's atmosphere; a permanent rise, perhaps, in the mean height of the barometer; and, if the gaseous matter should condense sufficiently to descend to the lower regions of our atmosphere, some effect upon animal or vegetable exist-

ence, good or bad. The Earth may actually have been many times in the tail of a comet, without having any strong marks of such an accident.

The bodies of comets have varied from 30 to 3000 miles in diameter; some of them have been entirely destitute of tails, and others have exhibited them 100,000,000 of miles in length. They move in narrow, elliptical orbits, travelling to an immense distance out of our system, and at their return approaching, in most cases, much nearer to the Sun than any of the planets. Of three of them the periodical revolution has been ascertained. Encke's comet revolves in



Encke's Comet.

three years and a half; Biela's in six and three quarters; and Halley's in seventy-five years and a half; the last of these made its appearance in 1835. A comet with a tail of uncommon magnitude, but with a nucleus scarcely perceptible, visited us in 1843. The great comet of 1680, when at its perihelion, or point nearest the Sun, was only at the distance of one sixth of his diameter from that great body of fire; it conse-

quently was exposed to a heat 27,500 times greater than that received by the Earth—a degree so intense as to convert into vapor every terrestrial substance with which we are acquainted. One hundred and forty comets have appeared within the Earth's orbit during the last century, which have not again been seen. If a thousand years be allowed as the average period of each, it may be computed, by the theory of probabilities, that the whole number ranging within the Earth's orbit must be 1400. But Uranus being twenty times more distant, there may be no less than 11,200,000 comets that come within the known extent of our system.

The trains of comets are always thrown off in a direction opposite to the Sun. No satisfactory solution of the nature and cause of these has been assigned. The effect is the same as if the nucleus of the comet were a globe of water, and the Sun, in shining through it, cast its refracted rays to a distance beyond.

THE FIXED STARS.

Such is a brief description of the solar system, which, down to the beginning of the present century, comprised within its limits almost the whole of astronomical science. Before this period, the planetary orbits seemed to encircle all the space accessible to the human eye; they had effectively established limits to systematic inquiry; for astronomers had never pushed their researches into remoter depths, having, like the uninstructed multitude, gazed at the farther heavens with vague and incurious glances, content to admire their beauty and confess their mystery. This period,

however, was distinguished by two events which could not have existed in combination without leading to important results. The *telescope*, formerly of very limited range, suddenly assumed a capability of sounding immense profundities of space; and the man in whose hands it attained this new power was possessed of a genius adequate to improve the highest opportunities. The life of Sir William Herschel marks the first and greatest epoch of modern astronomy. He was a discoverer of the first rank: mingling boldness with a just modesty, a thirst after large and general views with a habit of scrupulous obedience to the intimations of existing analogies, he was precisely the man to quit paths which, through familiarity, were common and safe, and to guide us into regions dim and remote, where the mind must be a lamp to itself.

Herschel communicated to the world the first proof that there existed in the universe organized systems besides our own; while his magnificent speculations on the Milky Way, and the constitution of the Nebulæ, first opened the road to the conception that what was called the universe might be, and in all probability is, but a detached and minute portion of that interminable series of similar formations which ought to bear the same name.

But before we pursue this topic farther, it will be necessary to give an account of the FIXED STARS, or that stellar firmament to which the solar system belongs. About 2000 of these stars are visible to the naked eye; but when we view the heavens with a telescope, their number seems to be limited only by the imperfection of the instrument. In one hour Sir William Herschel estimated that 50,000 stars passed

Fixed Stars.

through the field of his telescope in a zone of the heavens two degrees in breadth. It has been calculated that the whole expanse of the heavens must exhibit about 100,000,000 of fixed stars, within the reach of telescopic vision. These stars are classed according to their apparent brightness; and the places of the most remarkable of those visible to the naked eye, are ascertained with great precision and formed into a catalogue. The whole number of stars registered amounts to about 200,000. The distance of the fixed stars is too great to admit of their exhibiting a perceptible disk. With a fine telescope, they appear like mere luminous points. Their twinkling arises from sudden changes in the refractive power of the air, which would not be sensible to the eye if they had disks, like the planets. Thus we can learn nothing of the relative distances of the fixed stars from us, and from one another, by their apparent diameters;

but as they do not appear to change their position during the passage of the Earth from one extremity of its orbit to the other, it is evident that we must be more than 200,000,000 miles distant from the nearest. Many of them, however, must be vastly more remote; for, of two stars that appear close together, one may be far beyond the other in the depth of space. The light of Sirius, according to the observation of Sir John Herschel, is 324 times greater than that of a star of the sixth magnitude.

Nothing is known of the absolute size of the fixed stars; but the quantity of light emitted by many of them shows that they must be much greater than the Sun. Sirius is nearly four times larger, and many stars must be infinitely larger than Sirius. Sometimes stars have been known to vanish from the heavens, and never appear afterwards; the lost Pleiad of classical mythology is one of these. The last disappearance of a star, noted by astronomers, was in 1828. Sometimes stars have all at once appeared, shone with a bright light, and vanished. A remarkable instance of this occurred in the year 125, which is said to have induced Hipparchus to form the first catalogue of stars. Another star appeared near the constellation of the Eagle in 389, and vanished, after remaining for three weeks as bright as Venus. On the 10th of October, 1604, a brilliant star burst forth in the constellation of Serpentarius, which continued visible for a year. A more recent case occurred in 1670, when a new star was discovered in the head of the Swan, which, after becoming invisible, reappeared, and having undergone many variations of light, vanished after two years, and has never since been seen.

In 1572, a star was discovered in Cassiopeia, which rapidly increased in brightness till it even surpassed that of Jupiter; it then gradually diminished in splendor, and having exhibited all the variety of tints that indicate the changes of combustion, vanished sixteen months after its discovery, without altering its position. It is impossible to imagine any thing more tremendous than a conflagration that could be visible at such a distance. It is, however, suspected that this star may be periodical, and identical with those which appeared in 945 and 1264. There are, probably, many stars which alternately vanish and reappear, among the innumerable multitudes that spangle the heavens; the periods of thirteen have already been pretty well ascertained.

Of these the most remarkable is in the constellation of the Whale. It appears about twelve times in eleven years, and is of variable brightness, sometimes seeming like a star of the second magnitude; but it does not always attain the same lustre, nor increase and diminish by the same degrees; it goes through a complete revolution of brightness and obscurity in little less than three days. The cause of the variations in most of the periodical stars is unknown, but it is conjectured that they may be occasioned by the revolution of some opaque body coming between us and them. Sir John Herschel is struck with the high degree of activity evinced by these changes, in regions where "but for such evidences we might conclude all to be lifeless."

Many thousands of stars seem to be only brilliant points; but, when carefully examined, are found to be,

in reality, systems of two or more suns, revolving round each other, or round a common centre. These double and multiple stars are very remote, requiring the most powerful telescopes to show them separately. The motions of revolution of many of these stars round a common centre have been ascertained, and their periods determined with considerable accuracy. Some have accomplished a whole revolution, since their discovery. One of these stars revolves round the other in 1600 years, another in 58. It sometimes happens that the edge of the orbit of a star is presented towards the Earth ; it then seems to move in a straight line, and to oscillate on each side of its primary. There are also quadruple stars, and even assemblages of five and six, revolving round each other.

Besides revolutions around one another, some of the binary systems are carried forward in space, by a motion common to both stars, toward some unknown point in the firmament. Two stars in the Swan, which are nearly equal, and have remained at the same distance from each other for above fifty years, have changed their place in the heavens, during that period, between four and five minutes, with a motion which for ages must appear uniform and rectilinear, because, even if the path be curved, so small a portion of it must appear a straight line to us. The single stars, also, have proper motions; our own Sun is supposed to be moving towards a certain point in the heavens.

Though the absolute distance of the fixed stars is still unknown, a limit has been found within which, probably, some of them come. It was natural to suppose that, in general, the large stars are nearer to the

Earth than the small ones; but there is now reason to believe that some stars, though by no means so brilliant, are nearer to us than others which shine with greater splendor. This is inferred from the comparative velocity of their movements. In consequence of the progressive motion of our Sun, and its planets, all the fixed stars have an *apparent* motion, which tends ultimately to mix the stars of the different constellations; but none that we know of moves so rapidly as No. 61 of the Swan; and on that account it is reckoned to be nearer to us than any other,—for an object which we are passing by seems to move more quickly, the nearer we are to it.

This circumstance induced Messrs. Arago and Matthieu to endeavor to determine its annual parallax; that is, to ascertain what magnitude the diameter of the Earth's orbit would have, as seen from the star. They found, by observation, that the orbit's diameter of 190 millions of miles would be seen from the star under an angle of only half a second; whence this star must be at the distance of 420 *millions of times* 190 *millions of miles from the earth!*—a distance which light, flying at the rate of 190,000 miles in a second, would not pass over in less than six years. This is the smallest distance at which the star can be: how much greater its real distance is, it is impossible to say. The apparent motion of five seconds annually, which this star has, seems to us extremely small; but at that distance an angle of one second corresponds to 24 millions of millions of miles; consequently, the annual motion of this star is 120 millions of millions of miles; and yet, as M. Arago observes, we call it a *fixed* star!

The double stars are of various hues, but they most frequently exhibit the contrasted colors. The large star is generally yellow, orange, or red; and the small star blue, purple, or green. Sometimes a white star is combined with a blue or purple one, and more rarely a red and white one are united. In many cases, these appearances arise from the influence of contrast on our judgment of colors. For example, in observing a double star, when the large one is a full ruby red, or almost blood color, and the small one a fine green, the latter loses its color when the former is hidden by the cross-wires of the telescope. But there is a vast number of instances where the colors are too strongly marked to be merely imaginary. Sir John Herschel observes, as a very remarkable fact, that, although red stars are common enough, no example of a solitary blue, green, or purple one has been produced.

The stars are very irregularly scattered over the firmament. In some places, they are crowded together, in others thinly dispersed. A few groups, more closely condensed, form very beautiful objects even to the naked eye, — of which the Pleiades, and the constellation Berenice's Hair, are the most striking examples. But the greater number of these clusters of stars appear, to unassisted vision, like thin white clouds, or vapor; such is the Milky Way, which, as Sir William Herschel has proved, derives its brightness from the diffused light of the myriads of stars that form it. Most of these stars appear to be extremely small, on account of their enormous distances.

This singular portion of the heavens, constituting part of our firmament, consists of an extensive mass

of stars, the thickness of which is small compared to its length and breadth; the Earth is placed at the point where it divides into two branches, and it appears to be much more splendid in the southern hemisphere than in the northern. Sir John Herschel says, "The general aspect of the southern circumpolar regions, including in that expression 60 or 70 degrees of south polar distance, is in a high degree rich and magnificent, owing to the superior brilliancy and large development of the Milky May, which, from the constellation of Orion to that of Antinous, is a blaze of light, strangely interrupted, however, with vacant and entirely starless patches, especially in Scorpio, near Alpha Centauri and the Cross; while to the north it fades away pale and dim, and is, in comparison, hardly traceable. I think it impossible to view this splendid zone, with the astonishingly rich and evenly-distributed fringe of stars of the third and fourth magnitude, which forms a broad skirt to its southern border, like a vast curtain, without an impression, amounting almost to conviction, that the Milky Way is not a mere stratum, but annular; or, at least, that our system is placed within one of the poorer or almost vacant parts of its general mass! The cluster of which our Sun is a member, and which includes the Milky Way and all the stars that adorn our sky, must be of enormous extent, since the Sun is more than 20 millions of millions of miles from the nearest of them; and the other stars, though apparently so close together, are probably separated from one another by distances equally great."

METEORITES.

If such remote bodies as the fixed stars shone by reflected light, we should be unconscious of their existence. Each star must then be a sun, and may be presumed to have its system of planets, satellites, and comets, like our own; and for aught we know, myriads of bodies may be wandering in space unseen by us, of whose nature we can form no idea, and still less of the part they perform in the economy of the universe. Even in our own system, at its farthest limits, minute bodies may be revolving like the new planets, which are so small that their masses have hitherto been inappreciable, and there may be many still smaller.

Nor is this an unwarranted supposition; many such do come within the sphere of the Earth's attraction, are ignited by the velocity with which they pass through the atmosphere, and are precipitated with great violence on the Earth. The fall of meteoric stones is much more frequent than is generally believed. Hardly a year passes without some instances occurring; and if it be considered that only a small part of the Earth is inhabited, it may be presumed that numbers fall in the ocean, or on the unoccupied part of the land, unseen by man. They are sometimes of great magnitude; the bulk of several has exceeded that of the planet Ceres, which is about 70 miles in diameter. One, which passed within 25 miles of the Earth, was estimated to weigh about 600,000 tons, and to move with a velocity of about 20 miles in a second; a fragment of it alone reached the ground. The obliquity of the descent of meteorites, the peculiar substances of which

they are composed, and the explosion accompanying their fall, show that they are foreign to our system.

Luminous spots have occasionally appeared on the dark part of the moon. These have been ascribed to the light arising from the eruption of volcanoes; whence it has been supposed that meteorites have been projected from the moon by the force of volcanic eruption. It has even been computed that if a stone were projected from the moon in a vertical line, with an initial velocity of 10,992 feet in a second, (more than four times the velocity of a cánnon-ball,) instead of falling back to the moon by the attraction of gravity, it would come within the sphere of the Earth's attraction, and revolve about it like a satellite. These bodies, impelled either by the direction of the primitive impulse or by the disturbing action of the Sun, might ultimately penetrate the Earth's atmosphere and arrive at its surface; but it is much more probable that they are asteroids revolving about the Sun, and diverted from their course by some disturbing force; at all events, they must have a common origin, from the uniformity of their chemical composition.

AËROLITES.

Shooting stars and meteors differ from *aërolites* in several respects. Aërolites burst from the clear azure sky, and, darting along the heavens, are extinguished without leaving any residuum except a vapor-like smoke, and generally without noise. Calculations have shown them to be very high in the atmosphere — sometimes even beyond its supposed limit; and the direction of their motion is, for the most part, opposite to the

motion of the earth in its orbit. The astonishing multitudes of shooting stars and fire-balls that have appeared within these few years, at stated periods, over the American continent, and other parts of the globe, warrant the conclusion that there is either a nebula, or that there are myriads of bodies revolving round the Sun, which become visible only when inflamed by entering our atmosphere.

One of these nebulæ, or groups, seems to approach close to the Earth, in its annual revolution, on the 12th or 13th of November. On the morning of the 12th of November, 1799, thousands of shooting stars, mixed with large meteors, illuminated the heavens, for many hours, over the whole continent of America, from Brazil to Labrador; they were observed even in Greenland and Germany. Meteoric showers were seen off the coast of Spain, and in Ohio, on the morning of the 13th of November, 1831. In 1832, during many hours of the morning of the 13th of November, prodigious multitudes of shooting stars and meteors fell at Mocha, on the Red Sea, in the Atlantic, in Switzerland and England.

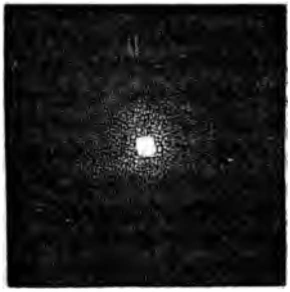
But by far the most splendid meteoric shower on record was in 1833. It began at nine o'clock in the evening of the 12th of November, and continued till sunrise the next morning. It extended from the great lakes of Canada, southward, to Jamaica, and from the 61st degree of longitude in the Atlantic, westerly, to the 100th degree in Central Mexico. Shooting stars and meteors, of the apparent size of Venus, Jupiter, and even the full moon, darted in myriads towards the horizon, as if all the stars in the heavens had started

from their spheres. Those who witnessed this grand spectacle were surprised to see that every one of these luminous bodies, without exception, moved in lines which converged to one point in the heavens. None of them started from that point; but their paths, when traced backward, met in it like rays in a focus, and the manner of their fall showed that they descended from it in nearly parallel straight lines. The most extraordinary part of the phenomenon is, that this radiating point was observed to remain stationary, in the constellation Leo, for more than two hours and a half, — which proves the source of the meteoric shower to be altogether independent of the Earth's rotation. Other observations showed it to be far above the atmosphere.

As all the circumstances of the phenomenon were similar, on the same day, and during the same hours, in 1832, and as extraordinary flights of shooting stars were seen at many places, both in Europe and America, on the 13th of November, 1834, and the two following years, proceeding also from a fixed point in the constellation Leo, it has been conjectured, with much apparent probability, that this nebula, or group of bodies, performs its revolution round the Sun in a period of about 182 days, in an elliptical orbit, and that its greatest distance from the Sun is about 95,000,000 of miles, which brings it in contact with the Earth's atmosphere.

NEBULOUS STARS.

We are now about to introduce to the reader's notice the most wonderful discovery ever made in the science of astronomy, — namely, a planetary system *in the process of formation*, or a chaos of matter gradually gath-



ering into the shape of suns with their attendant worlds! Certain dim spots, or diffused luminous patches, in the heavens, have long been known to astronomers by the name of *nebulæ;* but their phenomena were looked upon as inexplicable, and regarded as barren marvels, until Sir William Herschel completely surveyed them all, studied their curious relations, and formally presented his views concerning their probable nature. These nebulæ are of two sorts, planetary and stellar. In the former, we behold a starlike body, surrounded with a luminous atmosphere, which the strongest telescopes are unable to resolve into separate stars, but which, under every magnifying power, still continue to present the appearance of a vague film.

Sir John Herschel says of one of them, in Orion's sword, "I know not how to describe it better than by comparing it with the curdling of a liquid, or to a surface strewed over with flocks of wool, or to the breaking up of a mackerel sky, when the clouds begin to assume a linear appearance. It is not very unlike the

mottling of the sun's disk, only the grain is much coarser and the intervals darker, and the *flocculi*, instead of being round, are drawn into little wisps. They present, however, no appearance of being composed of stars, and their aspect is altogether different from those of resolvable nebulæ. In these we fancy, by glimpses, that we see stars, or that, could we strain our sight a little more, we should see them; but the former suggest no idea of stars, but rather of something quite distinct from them.

"In reference to the great nebula in the girdle of Andromeda, there are grounds for a similar conclusion. So that we have this novel and most singular matter not only surrounding stars, and enveloping them as an immense *chevelure*, but existing also isolated, and in various conditions, from the shape of perfect diffusion, to that where, as in Andromeda, it shows a central nipple, or an apparent point of condensation. It is, perhaps, in its separate and independent form that it fills us with most astonishment. The profusion with which it is distributed, in this form, in both hemispheres, and, indeed, through all the heavens, would imply that it fulfils, or is pressing to fulfil, some important function in the material economy."

This strange fluid, a self-luminous, phosphorescent, material substance, exists in a great variety of forms, but generally in a globular shape, and in all varieties of density. Some of the masses are only a thin milky patch, of equal tenuity in every part; in others, there is a slight condensation toward the centre: this condensation augments, till, at length, we behold a distinctly-formed star, surrounded by a nebulous atmosphere.

The inference is irresistible, that they are masses of chaotic matter, in a highly diluted or gaseous state, gradually subsiding, by the mutual gravitation of their particles, into stars and sidereal systems. This is the hypothesis of Laplace with regard to the origin of the solar system, which he conceived to be formed by the successive condensations of a nebula whose primeval rotation is still maintained in the rotation and revolution of the Sun, and all the bodies of the solar system, in the same direction. Even at this day, there is presumptive evidence, in the structure and internal heat of the Earth, of its having been at one period in a gaseous state, from an intensely high temperature.

The question will naturally occur here, How can such stars as we see come out of these nebulous masses? and can any star, thus produced, resemble in character the known individuals of our heavens? To a certain extent this inquiry has been answered, ingeniously and satisfactorily. It is manifest that the orbs arising out of a nebula would be subject to a motion of rotation on an axis, as the Sun is, and, in all probability, the fixed stars are. The confluence of particles toward a centre of attraction would, in general, if not universally, produce a whirlpool, of which an illustration is extant in the confluence of almost all differently-flowing streams. A rotary motion once communicated, its velocity would increase with the process of condensation. The resulting orbs, then, would rotate; and as the circumstances of their origin would vary, they would rotate in varying times. The phenomenon of the double stars is also explained here. The whirlpool motion of the original nebula would in-

evitably cause an orbitual revolution of binary and more complex systems. A diffused nebulosity is sometimes seen broken up into two or more round nebulæ, yet hardly separated. If these individual masses rotate, or are like whirlpools, they must act on each other as wheels; the result may be illustrated by a very familiar example. Walk along the side of a river, and notice the little moving eddies caused in such multitudes by the interference of currents from the unequal sides of the stream; follow these small eddies for a moment, and observe how, on being whirled down the stream, they come into contact or proximity to each other; that instant they *form a system*, the one revolving round the other, or rather both revolving round some intermediate point.

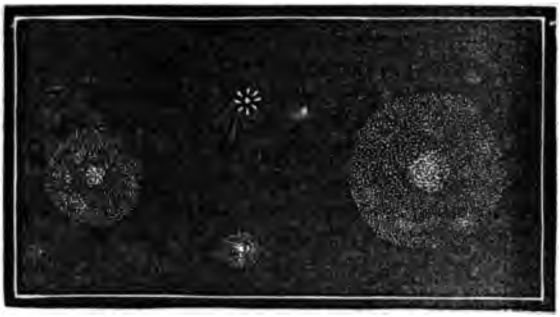
The Sun, and, probably, the other orbs, are attended by planets; and it is, perhaps, the most interesting part of the whole speculation, to follow Laplace in his account of the gradual formation of these minute circumstellar bodies from the bosom of the condensing nebula. In any given state of the rotating mass, the outer portion, or ring, is in the condition of having its centrifugal force exactly balanced by its gravity. The rotation increasing in rapidity in consequence of the progressing condensation, the mass of the nebula will abandon this outer ring of matter, which may afterwards continue to circulate about the star. Imagination may conceive several zones of vapor thus successively abandoned, and moving, with velocities corresponding to their position, around the Sun, or central nebulous mass. The particles of such rings might condense into a solid or liquid substance; but, unless the

formations were originally uniform in all their parts,— an improbable hypothesis,—they would not condense as rings. We have, in fact, only one example of such a circumstance in the rings of Saturn,—a phenomenon altogether invaluable in illustration of the primary condition of our system. In most cases, these zones would divide, and form several masses, circulating around the Sun. The same process, in the mean time, would be going on with regard to the planets, in the formation of their satellites.

Distinct evidences of the originally nebulous state of the solar system are not wanting. There is a phenomenon called the zodiacal light, which may be seen in the twilight of morning and evening, in the neighborhood of the Sun, in the shape of a pyramid, or cone, rising above the horizon, and considerably inclined on one side. It appears to extend beyond the orbit of Venus, and is regarded as a portion of the original nebular mass of our system not yet condensed. The comets, moreover, are evidently nebulous bodies, and most of them are strangers to our system, or rather, fortuitous visitants. This fact merely indicates that we must seek their origin in the external spaces, and we find it in those masses of nebulous fluid with which they are intimately connected by constitution, and whose formerly questionable existence they render visible and almost tangible. How interesting the change which passes over the whole aspect of these wandering bodies, when viewed in their true position, not as anomalies, not as monstrous and disturbing intruders into a system with which they are not connected by any harmonizing ties, but as outposts of a mighty sys-

tem, which vastly extend our notions of that amount of formless matter existing among the stellar intervals, and which are themselves in progress toward a more perfect organization!

In illustration of the process of the formation of stars and systems from nebulæ, the following cut speaks to the eye, and is more valuable than pages of description. Each figure in this plate is the representation,



Stars and Systems forming from Nebulæ.

not of an individual, but of an extensive class; and it would seem that a series so well marked, so striking in its aspects, must indicate the presence and influence of a great law. From absolute vagueness to distinct structure, and then on to the formation of a defined central nucleus, the nebula seems growing under our eye! "We look," says Laplace, "among these objects as among the trees of a forest; their change, in the duration of a glance, is undiscoverable: yet we perceive that these are plants in all different stages; we see that these stages are probably related to each other in the order of time, and we are irresistibly led

to the conclusion that the vegetable world, in the one case, and the sidereal world in the other, exhibit, at one instant, a succession of changes requiring time, which the life of man, or the duration of the solar system, may not be sufficient to trace out in individual instances."

There is a creature called the ephemeron, whose life is limited within a mere point of time; in a single day it dances out its existence in the sunbeam. That creature lives in the presence of all the phenomena of vegetable growth; it may see trees, it may see flowers; but how could it, or its generations, actually observe their progressive development? In relation to the nebulæ, man is but an ephemeron. Fifty lives succeeding each other, and of a length to which individuals often attain, would reach backward beyond the recorded commencement of his race; and, in the mutability of things, fifty more may close its career. Thus no more than what one hundred ephemera can see of the progress upward of the majestic pine, will man, perhaps, ever actually behold of the changes of the nebulæ.

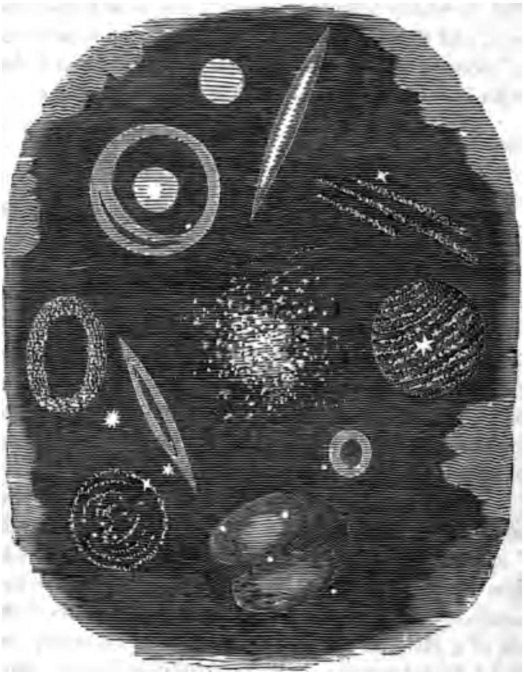
Yet, after all, where is the intrinsic difference between the formation of a system of worlds, and the growth and progress of the humblest leaf from its seed to its intricate and most beautiful organization? That which bewilders us is not any intrinsic difficulty or disparity, but a consideration springing from our own fleeting condition. We are not rendered incredulous by the *nature*, but overwhelmed by the *magnitude*, of these creations; our minds will not stretch out to embrace the periods of this stupendous change. But time is illimitable, and we are speaking of the operations, and tracing the footsteps, of a Being who is above all time; we are contemplating the energies of that almighty

mind, to whose infinite capacity a day is as a thousand years, and the lifetime of the entire human race but as the moment which dies with the tick of the clock that marks it — which is heard and straightway passes.

THE FIRMAMENTAL SYSTEMS.

Notwithstanding the amazing extent of the worlds, and systems of worlds, we have described, they do not constitute the whole universe, but only a very small part of it. Countless *firmaments*, or clusters of stars, distinct from ours, and at an immense distance from it, exist, sustaining an independent position, as individual constituents of creation. We have already carried our researches into what seemed the infinity of space; but we must now go forth into far deeper infinity among these firmaments, and ascertain their character.

In the intervals between the stars of our own system, and at an immense distance beyond them in the depths of space, many clusters of stars may be seen, like white clouds, or round comets without tails. When examined with proper instruments, they convey the idea of a globular space, insulated in the heavens, and filled full of stars, constituting a family, or society, apart from the rest, subject only to its own internal laws. The number of these masses is very great. In the northern hemisphere, after making all allowances, those whose places are fixed cannot be fewer than 1000 or 2000; and we may form some idea how plentifully they are distributed, by recollecting that this is at least equal to the whole number of stars which the naked eye beholds at once on any ordinary night.



Various Forms of Nebulæ.

To attempt to count the stars in one of these clusters, would be a vain task; they are to be reckoned not by hundreds, but by thousands. On a rough computation, it appears that many of them must contain 10 or 20,000 stars, compacted and wedged together in a globular space, whose area is not more than a tenth part of that covered by the moon; so that its centre,

where the stars are seen condensed, is one blaze of light. If, as we have every reason to believe, each of these stars be a sun, and if they be separated by intervals equal to that which separates our Sun from the nearest fixed star, the distance which renders the whole cluster barely visible to the naked eye, must be so great, that the existence of this splendid assemblage can only be known to us by light which must have left it a thousand years ago!

These clusters have a variety of shapes — some of them most singular and fantastic. In many of them, individual stars are distinctly defined. As they become more remote, the intervals between the stars diminish, and the light grows fainter. In their faintest stellar aspect, they may be compared to a handful of fine, sparkling sand, or, as it is aptly termed, *star-dust.* Beyond this we see no stars, but only a streak, or patch, of milky light. Vast multitudes of these are so faint as to be with difficulty discerned at all, till they have been for some time in the field of the telescope, or are just about to quit it. Occasionally, they are so vague, that the eye is conscious of something, without being able to define what it is; but the unchangeableness of its position proves that it is a real object.

The central cluster of stars, in the preceding cut, is a good specimen-object, as it is a representative, or type, of a very large class. Notwithstanding the partial irregularity of its outline, it seems almost a spherical mass, in which, with a degree of greater compression toward the centre, the stars are pretty equally and regularly diffused, so that, to the inhabitants of worlds near its central regions, its sky would spangle

uniformly all around, and present no phenomenon like the Milky Way, in ours. Others of the spherical clusters show a much greater compression about the centre — a circumstance which would manifestly augment the proportionate number of orbs of the first magnitude in view of those living within the compressed portion, and thus render their visible heavens inconceivably brilliant. Firmaments, however, are by no means confined to the spherical form, as we have already remarked. In the southern hemisphere, a phenomenon, known by the name of the Magellanic Clouds, long excited the wonder of all beholders. These clouds have been found to be immense nebulæ, or firmaments, of a singular shape. The following is a representation of one of them.

This nebula, according to the description of Sir John Herschel, who spent some time at the Cape of Good Hope, in astronomical researches, "is a congeries of clusters of irregular form, globular clusters, and nebulæ of various magnitudes and degrees of condensation,

among which is interspersed a large portion of irresolvable nebulæ, which may be, and probably is, star-dust, but which the powers of the twenty-feet telescope show only as a general illumination of the field of view, forming a bright ground, on which the other objects are scattered. Some of the objects in it are of very singular and incomprehensible forms — the chief one especially, which consists of a number of loops, united in a kind of unclear centre or knot, like a bunch of ribbons disposed in what is called a true-love knot. There is no part of the heavens where so many nebulæ and clusters are crowded into so small a space as this cloud!"

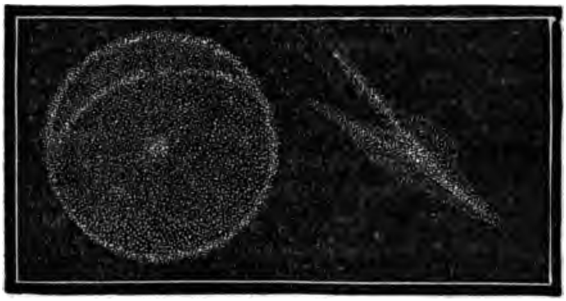
But it is when we arrive among the almost bewildering multitudes of unresolved systems, that we are most forcibly struck by the variations of their fantastic shapes. The unresolved clusters being at depths much profounder than the sites of the others, the sphere appropriated to them is, of course, of larger radius, and far more capacious, so that there is room for greater numbers, and also a more wonderful display of variety. The accompanying sketch exhibits a few of these

curious shapes. The annular form sometimes occurs; one fine instance of it is in the constellation of the Lyre. The oblong sharp hoop, represented in the preceding cut, is probably likewise a large ring, but appearing sharp in consequence of its oblique position with regard to us. How utterly different from ours must be the aspects of the sky to the inhabitants of such a firmament! The space within the ring is nearly a blank, but not perfectly so, a very thin mass of light spreading over it; so that, to the eye of a spectator placed within the space, the sides will appear nearly an utter blank, while the other part of the heavens will be engirdled with a zone of the most dazzling lustre.

One of the most singularly-shaped clusters is the large object in the preceding page. It has the shape of an hour-glass, or dumb-bell; the two connected hemispheres, as well as the connecting *isthmus*, being bright and beautiful, manifesting a dense collection of stars in those regions, while the oval is completed by two spaces, which do not transmit a greater quantity of light, nor indicate the presence of a larger number of stars, than the comparatively vacant interior of the ring above described. We are lost in mute astonishment at these endless diversities of character and form. But in the apparent aim of the things near and around us, we may perhaps discern some purpose which such variety may serve. It seems the object, or result, of known material arrangements, to produce every variety of creature; and perhaps it is one end of this wonderful evolution of firmaments of all orders, magnitudes, and forms, that there, too, the law of variety may prevail,

and room be found for unfolding the whole riches of the Almighty.

Of all these wonderful exhibitions, there is no one more singular than what we are about to describe. Although the telescope has not yet enabled us to lay out the plan of our own cluster from *interior* surveys, it exhibits what seems to be its very picture hung up in external space. The accompanying cut represents a nebula resting near the outermost range of telescopic



observation, which is the *fac simile* of the system to which we belong! A double representation is given, one of them showing it in a broadside, and the other in an edgewise view. It has its surrounding ring, of the precise form which we have been inclined to attribute to our Milky Way. It adds much to the interest with which we contemplate this cluster, that the inhabitants there must see our system precisely as we see theirs—namely, sideways; so that we behold objects of the same aspect when we look at each other. Singular affinity of forms! What link, what far-reaching sympathy,

can connect these twin masses, — that unfathomed firmament and ours! What virtue is there in a shape so fantastic, that it should be thus repeated? — or what is the august law, exerting its force at the opposite extremities of space, which has caused these corresponding shapes to come into being?

Struck with an absorbing and most natural astonishment, we soon start the inquiry, *What are these clusters doing?* What is their internal condition? What are their mechanisms? And what the nature and affections of the bodies which compose them? Here we approach the region of clouds and doubt; the solid ground of fact and observation begins to fail us. Yet we are not without warrant in pronouncing that these vast masses are not grouped together by chance, or at random, but that every such union of stars indicates law and system. The only light we find, among these immense spaces, is a welcome gleam of evidence that nature there is also uniform, since the simpler firmaments manifest, by their shapes, the prevalence of an *internal attractive power.* Notwithstanding the fantastic forms which sometimes occur, the round or globular structure is the general or favorite one; and in most of these round clusters there is also a strongly-marked increase of light towards the centre, much more than would arise from the circumstance of the eye then looking through the deepest part of the group, and thereby seeing, at once, the greatest number of its stars. This phenomenon decidedly indicates *compression*, in a greater or less degree; nor is it confined to masses having the perfectly spherical figure. "There are besides," says Sir William Herschel, "additional

circumstances, in the appearance of extended clusters and nebulæ, which very much favor the idea of a power lodged in the brightest part. Although the form of these be not globular, it is plainly to be seen that there is a tendency to sphericity, by the swell of the dimensions the nearer we draw towards the most luminous place — denoting, as it were, a *course, or tide, of stars,* setting towards a centre. And if allegorical expressions may be allowed, it should seem as if the stars, thus flocking towards the seat of power, were stemmed by the crowd of those already assembled, and that while some of them are successful in forcing their predecessors sideways out of their places, others are themselves obliged to take up lateral situations, while all of them seem eagerly to strive for a place in the central swelling and generating spherical figure."

Here another grand field for contemplation is opened. Even the heavens are not stable! These globular masses, at least, are in process of growth, are *ripening;* they are congregating together toward that nucleus round which a new order of things is slowly growing up, and where, perhaps, a mighty orb, whose dimensions almost affright the imagination, is preparing for its birth. And this process is, after all, only the prolongation of the condensing of a simple nebula. Already, some few of its particles have come together and formed its secondary stage; and now that secondary stage, which we term a firmament, is passing into a third, where all the dispersed atoms will be gathered together, and lodged at the centre of the mass!

Our own firmament presents appearances which not only sustain the foregoing conclusions, through a strong

analogy, but point the way to still bolder thoughts. The Milky Way has been already described as a ring, for the most part isolated, in which the stars are very dense, and where the aggregating power has drawn them from the general mass, and, by some curious operation, compressed them into a crowded girdle. But neither is this girdle uniform. It is divided into groups, chiefly inclining to the spherical form, and separated from each other by dark spaces, like *wrinkles of age.* Sir William Herschel counted no less than 225 such groups, or subordinate clusters, within the portion of it which he examined; and as all these were of a kind to mark the action of gravity, he inferred the existence of a clustering power, drawing the stars of it into separate groups,—a power which had broken up the uniformity of the zone, and to the irresistible force of which it was still exposed. "Hence," says he, in one of those bold moments in which he fearlessly traversed the infinities alike of past and future, "may we be certain that the stars will be gradually compressed through successive stages of accumulation till they come up to what may be called the *ripening period* of the globular cluster, and total insulation; from which it is evident that the Milky Way must forcibly be broken up, and cease to be a stratum of scattered stars. We may also draw an important additional conclusion from the gradual dissolution of the Milky Way; for the state into which the incessant action of the clustering power has brought it, is a kind of *chronometer*, that may be used to measure the time of its past and present existence. And although we do not know the rate and going of this mysterious chronometer, it is, nevertheless,

certain, that, since a breaking up of the parts of the Milky Way affords a proof that it cannot last forever, it equally bears witness that its past duration cannot be admitted to be infinite." Here is a vision of unfathomable changes — of the solemn march of the majestic heavens from phase to phase, obediently fulfilling their awful destiny.

If the aggregation of the stars in the Milky Way still goes on, as it prognosticates, for ages, the clusters which now, with some intermission, form its ring, will become isolated, and appear in the character of separate systems. But if this may happen in future time, may not something similar have happened in time past? The aspect of the heavens affords much to countenance this supposition. We can point out, for instance, a cluster of a remarkably irregular form, very narrow in one direction, and surprisingly ragged in the edges. Can it be possible that masses of stars have been torn away from it in certain directions, so that its thinness may simply indicate that, through the action of some irresistible cause, parts of it had there ripened sooner? Singular to relate, it is precisely towards these thin sides, and almost immediately beyond them, that the vast mass of *neighboring* isolated clusters is found — clusters all spherical, and grouping together in extraordinary proximity.

But these operations are, perhaps, only types of what may have occurred on a far more majestic scale. The separate firmaments which our telescopes have discovered show, even more emphatically than the groups in the Milky Way, the efficacy and progress of a clustering power. May not *they* all have come originally

from one homogeneous stratum, or mass of stars,—so that their present isolation, their separation, and various grouping, are only the measured movements of the clock, the gigantic steps of the hand, by which Time records the days of the years of the existing mechanism of the universe? Stupendous the conception, that these great heavens—the heavens which we have deemed a synonyme of the Infinite and Eternal—are nothing else, after all, than one aspect in which matter is destined to present itself, and that their history is like the birth, life, death, and dissolution, of the fragile plant! If this, indeed, be true,—and the idea can be supported by many probabilities,—how immense the sphere of real existence! How little can we ever know of it! at least, how much must be referred to that higher state of existence, an expected eternity of sublime contemplation!

PROPERTIES OF MATTER.

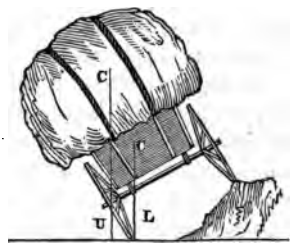
MATTER is the general name which has been given to every species of substance, or thing, which is capable of occupying space, or which has the qualities of length, breadth, and thickness; consequently, every thing which can be seen or felt, is said to be matter. In describing the properties of matter, it must be understood that they do not apply to the masses, or substances, commonly met with, but to the uncompounded or primitive materials of which such substances are formed. These original component parts, of which all substances

are made up, are styled simple matter, elementary principles, or, simply, elements. The ancients, as is well known, supposed that there were but four elements, or simple substances — Fire, Air, Earth, and Water; and out of these, or certain combinations of them, all the substances in nature were formed. But modern chemistry, as we shall show hereafter, has discovered that these elements are by no means simple, but capable of being decomposed.

Every solid body, or dense mass, possesses what is called a *centre of gravity*, which is the point upon or about which the body balances itself, and remains in a state of rest, or equilibrium, in any position. The centre of gravity may be described as a point in solids which always seeks its lowest level. In round, square, and all regularly-shaped bodies, of uniform density in all their parts, the centre of gravity is the centre of these bodies. When a body is shaped irregularly, the centre of gravity is the point upon which the body will balance itself, and remain in a state of rest.

The *line of direction* is an ideal line drawn from the centre of gravity of any body, and passing to the ground in a direction perpendicular to the earth's surface. When this line falls within the base of the body, or the part upon which it stands, the body will keep its position; but if the line falls without the base, the body will fall, or overturn. By keeping this principle in view, stability and safety will generally be secured in the erection of works of art, — such as houses, monumental edifices, spires, steeples,— as well as in the lading of wagons, and carts, and other vehicles. In every instance, the base ought to be sufficiently large to

admit of the line of direction falling within it. Through ignorance of this principle, and from want of experience, we often see stage-coaches and wagons laden in such a manner that their centre of gravity is liable to too great a change of position, and that they are overturned, to the personal injury, and even loss of life, of the passengers. In the annexed cut, a loaded vehicle



is represented as crossing the side of a hill, which has raised one wheel above the level of the other wheel, so as to incline the body of the vehicle very considerably from the horizontal. The centre of gravity is represented in two different positions; a lower one with the line of direction L C, and a higher one with the line of direction U C. If there had been no load upon the vehicle, the line of direction would have remained at L C; and as it falls within the wheel, or base, the vehicle would have maintained its balance. But if the wagon had been laden, the centre of gravity would have been raised, and, the line of direction U C consequently falling without the wheel, the vehicle must overturn.

An exception to this rule occurs in the case of

skaters, in making their circular turns on the ice, in which they bend, or lean, greatly beyond the perpendicular position, without falling. This is owing to the contrary effects of *centrifugal force*, a notice of which will next engage our attention. All bodies, in flying round a centre, have a tendency to proceed in a straight line; and this principle of motion is termed *centrifugal force.* Examples of this tendency are very familiar to our observation. When we whirl rapidly a string with an apple at one end of it, and suddenly allow the apple to fly off, it proceeds at first in a straight line, but gradually falls to the earth. We see many applications of this principle every day; great use is made of it, also, in manufactures and machinery. In the grinding of corn, and in the making of pottery and glass, it saves much trouble and expense. If a skater or equestrian should stand perfectly upright while turning corners and describing circles, he would inevitably fall on his side, being overturned by the centrifugal force. But by leaning inwards, the centrifugal force is counteracted by gravity, and this forms a support to his overhanging body.

Thus, centrifugal force is the tendency to fly off in a straight line from motion round a centre; and the power which prevents bodies from thus flying off, is called the *centripetal*, or *centre-seeking* force. In the case of the apple, the centrifugal force is the impetus given to the apple, which would make it fly away, if the string were to break. The centripetal force is the string, which prevents it from flying away, and gives a circular direction to its motion.

It is upon the mutual action of these two forces that

the stability of the solar system depends. If the tendency of the earth and planets to gravitate towards the sun were removed, they would fly off from it in perfectly straight lines, and never return; and if it were not for the centrifugal force, which is a result of their circular motion, they would rush to the very body of the sun; and, in either case, the harmony of the solar system would be entirely overturned.

Bodies, on being projected by any impulsive force, are called *projectiles*, and are observed to pursue a curvilinear and bent line of direction in their motion. The bending from the straight line is produced by the force of gravity, and "*the change is proportional to the impressed force.*" A ball fired from a cannon, a stone thrown from the hand, and water spouted from a confined vessel, furnish familiar examples of curvilinear motion.

The investigation of the paths which bodies describe when thrown, and of many things relating to their motion, results in certain definite rules, called the *laws of projectiles.* Skilful generals, in bombarding towns, and attacking vessels, at safe distances, take great advantage of their knowledge of these laws.

There are many very interesting circumstances connected with this subject, which our space will not allow us to notice.

Notwithstanding the various substances which nature offers to our observation may differ essentially in touch, weight, and appearance, yet the elements of which they are composed all possess the common, mechanical properties of matter, which properties are five in number — namely, 1. The particles of matter are *solid*, and

occupy space. 2. They are *infinitely divisible.* 3. They are *impenetrable.* 4. They possess mobility, but are *inert.* 5. They universally *attract* and are attracted. The first of these properties needs no proof; for the definition already given of matter is, that it has length, breadth, and thickness; and nothing can have these properties without occupying space, and being solid. These characteristics exist in all matter, although at first they may be invisible: thus air, which cannot be seen, is matter; for if a glass tube, open at both ends, have its upper end closed by the finger while its lower one is immersed in a jar of water, it will be seen that the air is material, and occupies its own space in the tube, for it will not permit the water to enter it till the finger is removed, when the air will escape, and the water will rise to the same level inside, as outside, of the tube.

The second property of matter is, that it is infinitely divisible; or, in other words, that the original component parts, or elementary particles, of which all things are formed, are small beyond conception. Thus, if marble, or any other brittle substance, be reduced to the finest powder which human art can produce, its original particles will not be bruised or affected — since, if this powder be examined by a microscope, each grain will be found to be a solid stone, similar in appearance to the block from which it was broken, and of course, if we possessed suitable implements, would admit of being again subdivided, or reduced to a still finer powder. If a single grain of copper be dissolved in about fifty drops of nitric acid, and the solution be afterwards diluted with about an ounce of water, it is evident that

a single drop of it must contain an almost immeasurably small portion of copper. Yet, so soon as this comes in contact with a piece of polished iron, or steel, that metal will become covered with a perfect coat of copper, which shows how infinitely the copper can be divided without any alteration in its texture. Gold becomes so attenuated under the hammer, in forming it into gold leaf, that the 500,000th part of a grain is visible to the naked eye, or the 5,000,000th part through a microscope magnifying but ten times. It has been calculated that a pound of gold would gild a silver wire 24,000 miles in length, or capable of encompassing the globe. But the wonders of art sink into nothing when compared to those of nature. Leewenhoek, the celebrated microscopic observer, affirms, that he has counted two millions of animalculæ in a portion of the roe of a codfish no larger than a common grain of sand.

That matter is infinitely divisible, admits also of demonstration on mathematical principles; for if a particle of matter, however small, be laid on a plane surface, it must necessarily have an upper and an under part, or a part which touches, and a part which does not touch, the plane.

The third property of matter — its impenetrability — seems to have been adopted by Nature, that her works might be everlasting, and incapable of wearing out; for, although matter, in many instances, seems to disappear, as in the cases of burning and evaporation, yet chemistry distinctly proves that it is incapable of annihilation, and that the original particles, in all cases, still

exist, though, by a change of arrangement, they are made to assume a different appearance.

Mr. Olmstead, speaking of this subject, says, "In all the changes which we see going on in bodies around us, not a particle of matter is lost; it merely changes its form; nor is there any reason to believe that there is now a particle of matter either more or less than there was at the creation of the world. When we boil water, and it passes to the invisible state of steam, this, on cooling, returns again to the state of water, without the least loss. When we burn wood, the solid matter of which it is composed passes into different forms — some into smoke, some into different kinds of airs or gases, some into steam, and some remains behind in the state of ashes. If we should collect all these various products, and weigh them, we should find the amount of their several weights the same as that of the body from which they were produced; so that no portion is lost. Each of the substances into which the wood was resolved, is employed, in the economy of nature, to construct other bodies, and may finally reappear in its original form. In the same manner, the bodies of animals, when they die, decay, and seem to perish; but the matter of which they are composed merely passes into new forms of existence, and reappears in the structure of vegetables, or of other animals."

Even substances which appear soft, such as air and water, appear hard when submitted to proper examination. Thus a quantity of water, falling in an open tube, seems to exert no particular force, on account of the resistance which it meets with from the air; but if the

air be previously removed by the air-pump, there will be no resistance, and the water will sound like the falling of shot, or stones. This is called a water-hammer. Air differs from water in being elastic, but its solidity is shown by the difficulty of compressing a bladder filled with it.

The fourth property of matter — namely, that it possesses mobility, but is inert — is the constant object of our observation. By mobility is meant, that it may always be moved if a sufficient force be applied to overcome its weight, or *vis inertiæ:* and by being inert, we understand that it is inactive, or indifferent to either rest or motion, yet admits of either, but always exerts a power to remain in that state in which it is found. For instance, when a person is riding on horseback, and the horse suddenly stops; or is in a carriage, or boat, which is impeded by striking against an obstacle; the person is thrown forward, from his insensible endeavor to remain in the state of motion in which he then was. That this is the case with inanimate as well as animate nature, will appear by giving a sudden push to a bowl of water, when the water will flow over on the side on which the impulse was given; but if once the bowl is put in motion, and then suddenly stopped, it will flow over on the opposite side. Numberless other instances may be found, in the difficulty of putting heavy bodies, such as ships, loaded wagons, &c., into motion. From this property of matter, if a stone or any inanimate mass is undisturbed, it will remain forever motionless; and when once put into motion, would continue in it, and move forever, were it not prevented by the resistance of the air, and by friction.

Attraction is the fifth property of matter, and exists in every individual particle. All matter attracts, and is attracted, in proportion to its quantity; therefore, all things upon the earth incline, or are drawn, towards its centre, because the earth is the largest mass of matter in their immediate vicinity. There are several kinds of attraction — distinguished by the names of cohesion and gravitation — magnetic, electric, and elective attraction, or affinity. These, in their general effects, — with the exception of the last, — appear nearly similar, although they depend upon different circumstances.

The attraction of cohesion is that power which unites the separate or individual particles of matter, and forms them into masses, or bodies. This attraction, in general, does not extend to any sensible distance from the body; and hence, when the parts of any substance are separated or broken, it is difficult to unite them. But if they can be brought into sufficiently close contact, this attraction operates, and they are joined. On this principle, two pieces of hot iron may be hammered together and united. A plate of lead, and one of tin, passed together through a flatting-mill, become combined into one plate of metal. Glues, cements, and solders, act in the same manner, upon the respective substances to which they are applied, by stopping up the pores, or interstices, and making the contact more perfect. The agency of this principle is shown by pressing two lead planes together, when they will adhere so firmly as to require considerable force to separate them; and the increasing ratio of this attraction, as bodies approach each other, is very well shown by floating two corks on the surface of the water, when they will run together

with an accelerated motion. The power which holds all things to the earth's surface is this same attraction; but when spoken of as applying to worlds, it is called the attraction of gravitation.

As the attraction of cohesion is common to all matter, it would appear that particles of every description must indiscriminately cohere and stick together, and form substances; and, consequently, that an infinite variety of compounds would be found in nature, with almost an impossibility of any two of them being alike. Such would undoubtedly be the case, were it not for that modification of attraction called affinity, or elective attraction: this, however, belongs rather to chemistry, than to the present division of our subject. By this power, the general effects of cohesion are restrained, and only one particular species of matter will unite with another, unless, in some cases, by the interposition of a third or fourth material; in consequence of which, only a definite number of natural substances are formed, and the same thing always appears with nearly similar characteristics.

Capillary attraction is that species of attraction by which fluids are raised in small tubes, and is a modification of the attraction of cohesion. If a capillary tube, or tube of very small diameter, be immersed in fluid, that fluid will rise to a certain height in it proportionate to the size of its base, rising highest in the narrowest tubes. This depends on the cohesive attraction exerted by the sides of the tube, and accounts for sap rising in the pores or tubes of vegetables. The increasing force of this attraction with the diminished size of the tube, is beautifully shown by two

square glass planes, touching at one edge, and separated at the opposite one by a wedge. On immersing these in water, and then raising them out of it, a portion of the water will be retained in that mathematical curve denominated an hyperbola. Capillary attraction also causes fluids to rise in sponges, sugar, sand, and other porous bodies, as soon as they come into contact with them.

The comparative density of bodies — by which is meant their variation in weight while of the same dimensions — most probably depends upon their original molecules, or atoms, being of such forms, and so disposed, as to admit of their coming into more or less close contact. Thus a greater number of particles will pack, or lie, in any given space, if their forms are regular, than could do so were they irregular. For example, it may be supposed that 1,000,000 particles of gold are contained in a cubic inch of that metal: 500,000 particles of iron might also be capable of occupying the same space, and 100,000 particles of wood. In the iron and wood there must, therefore, be many more pores, or interstices, than in the gold; and of course the gold will be the heaviest, or most dense. This increased density and weight do not therefore arise from the individual particles of gold being heavier than those of wood, but from a greater number of them being forced into the same space; for the original particles of matter are presumed to be all of the same weight; and thus gold, which is one of the heaviest solids, will, when dissolved, remain suspended in ether, which is the lightest of all visible fluids. It is impossible to obtain the absolute weight of bodies

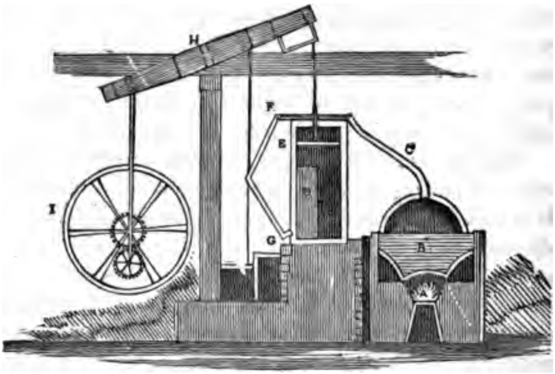
which vary in density, by weighing them in the open air, for the air will buoy up that which has the least density more than that which has the greatest. And thus, although a piece of cork and a piece of lead may exactly balance each other at the ends of a scale-beam, yet that balance will be destroyed as soon as they are placed in an exhausted receiver; for then the cork, by losing the buoyant assistance of the air, will preponderate; thereby proving that it contains more matter than the lead, though not in the same compass. This principle is sometimes further elucidated by the experiment of letting a guinea and a feather fall together in a glass receiver: when this is full of air, the guinea falls while the feather is floating about; but when the air is withdrawn from the receiver, they both reach the bottom at the same instant.

Since the earth is of a globular form, and the power of attraction is in proportion to the quantity of matter, so, of course, the inhabitants, and all things upon the earth's surface, will be attracted, or drawn downwards, in a direction tending to its centre; for since the longest line which can be drawn through a circle, or globe, is a diameter which must pass through its centre, so this will likewise pass through the greatest quantity of matter contained in any one direction in it, and consequently all bodies will fall in a direction pointing to the centre of the earth. Hence the use of plumb-lines for obtaining perpendiculars to the horizon, for setting the sides of buildings upright, &c.

Besides the above-described five properties of matter, it possesses yet another property, of great importance — namely, its power of arrangement, commonly

called *polarity*. The attraction of cohesion sufficiently accounts for the formation of masses, or substances, by drawing the original particles of matter together, and then holding them in contact; but it is found that they are not only drawn and held together, but that the same matter always takes the same arrangement, or formation. Thus a piece of iron, tin, or any other metal, or mineral, will, when broken, always exhibit the same arrangement and disposition of parts, or *grain*, as it is generally called. And so strictly are the laws of combination found to prevail in the union of elements, and formation of substances, that a novel and important character is given to modern chemical researches, approaching almost to mathematical precision; it being ascertained not only that the same materials will, in most cases, assume the same form, but that the ingredients which enter into the composition of substances do so in certain definite proportions, which cannot be changed without also changing the character of the substance they form.

THE MECHANICAL POWERS.

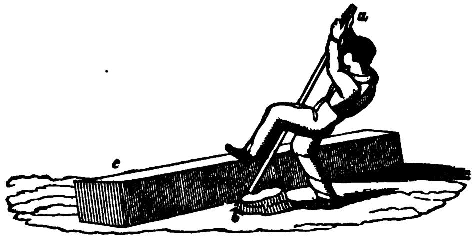


The Mechanical Powers are certain simple arrangements of machinery, by means of which weights may be raised, or resistance overcome, with the exertion of less power, or strength, than is necessary without them. In a mechanic power, the weight, or resistance, to be acted upon, and the power, or strength, which acts upon it, should both move at the same time; and any thing constitutes a mechanic power, in which the motion of the power produces a simultaneous motion in the resistance, provided less power is necessary than is due to the weight, or strength, of such resistance. From this general definition, it might appear that

every machine capable of generating force would be a mechanic power; but simplicity is likewise essential, and hence the mechanical powers may be said to be the elements of machinery; and they are, in fact, so elementary as to admit of no simplification or alteration. They are but six in number; and the names by which they are distinguished are, the LEVER, the WHEEL AND AXLE, the PULLEY, the INCLINED PLANE, the WEDGE, and the SCREW. Out of the whole, or a part, of these, it will be found that every mechanical engine, or piece of machinery, is constructed.

THE LEVER. This is the simplest of all the mechanical powers, and is generally considered the first. It is an inflexible bar, or rod, of any kind or shape, so disposed as to turn on a pivot, or prop, which is always called its *fulcrum*. It has the weight, or resistance, to be overcome, attached to some one part of its length, and the power which is to overcome that resistance applied to another; and as the power, resistance, and fulcrum admit of various positions with regard to each other, so the lever is divided into three modifications, distinguished as the first, second, and third kinds of lever — that portion of it which is contained between the fulcrum and the power being called the acting part, or arm, of the lever; and that part which is between the fulcrum and the resistance, its resisting part, or arm.

A beam, or rod, of any kind, resting at one part on a prop, or axis, which becomes its centre of motion, is a lever; and it has been so called, probably, because such a contrivance was first employed for lifting weights. This figure represents a lever used to move



a block of stone: *a* is the end to which the power, or force, is applied; *b* is the prop, or fulcrum; and *c* is the weight, or resistance: this is a simple crowbar, or handspike. According to a fundamental principle of dynamics, the power may be as much less intense than the resistance as it is farther from the fulcrum, or moving through a greater space. A man at *a*, therefore, — twice as far from the prop as the centre of gravity of the weight, *b*, — will be able to lift a weight twice as heavy as himself; but he will lift it only one inch for every two that he descends; for it is also a principle of this science that what is gained in power is lost in time.

There is no limit to the difference of intensity in forces which may be placed in opposition to each other by the lever, except the length and strength of the material of which the levers must be formed. Every one has heard of the boast of Archimedes, "Give me a lever long enough, and a prop strong enough, and with my own weight I will move the world!" But he must have moved with the velocity of a cannon-ball for millions of years, to alter the position of the earth

half an inch. In mathematical truth, this feat of Archimedes is performed by every man who leaps from the ground, for he kicks the world away from him when he rises, and attracts it again when he falls back.

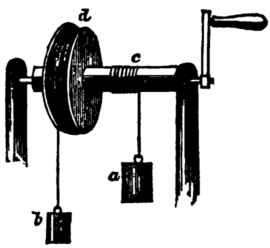
The common claw-hammer for drawing nails is a striking example of the power of a lever of this description. A boy who cannot exert a direct force of fifty pounds may, by means of this kind of hammer, extract a nail to which half a ton may be suspended, because his hand moves eight inches, perhaps, to make the nail rise one quarter of an inch. The claw-hammer also proves that it is of no consequence whether the lever be straight or crooked, provided it produces the required difference of velocity between power and resistance. The part of the hammer resting on the plank is the fulcrum. Pincers, or forceps, are double levers, and so are common scissors. The steel-yard is a lever with unequal arms.

The second kind of lever possesses the same degree of power with the first, and operates with the same results. The third kind cannot be called a mechanical *power*, for, since its resisting arm is longer than the acting arm, it must *lose* power, though it gains time. The most familiar examples of the occurrence of this kind of lever, are in the use of common fire-tongs, and in rearing a tall ladder against a wall. But the circumstance that principally gives importance to it, is, that the limbs of men and all animals are formed of it; for the bones are levers, the joints are the fulcra, while the muscles which give motion to the limbs, or

produce the power, are inserted and act close to the joints, causing action at the extremities.

To calculate the effect of a lever in practice, we must always take into account the weight of the lever itself, and its bending. But in speaking of the theory of the lever, we usually leave these out of the question, considering it as a rod without weight or flexibility.

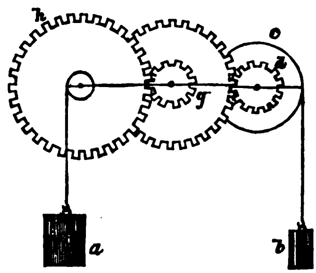
THE WHEEL AND AXLE. This power consists of two parallel wheels, pulleys, cylinders, or circles, having one axis in common. The letter *d* here marks the



wheel, and *c* an axle affixed to it. We see that, in turning together, the wheel would take up, or throw off, as much more rope than the axle as the circumference of the wheel is greater than that of the axle. If the proportions were as four to one, one pound, at *b*, hanging from the circumference of the wheel, would balance four pounds at *a*, hanging from the opposite side of the axle. A common crane for raising weights consists of an axle, to wind up, or receive, the rope which carries the weight, and of a large wheel, at the circumference of which the power is applied. The power may be animal effort on the outside of the wheel, or

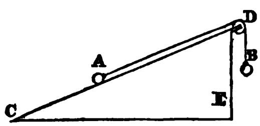
the weight of a man, or beast, walking on the inside, and moving it as a squirrel moves the cylinder of his cage.

By means of a wheel which is very large in proportion to its axle, force of very different intensities may be balanced, but the machine becomes of inconvenient proportions. It is found preferable, therefore, when a great difference of velocity is required, to use a combination of wheels, of moderate size. In the following figure, three wheels are seen thus connected. Teeth



in the axle, *d*, of the first wheel, *c*, acting on six times the number of teeth in the circumference of the second wheel, *g*, turn it only once for every six times that *c* revolves. In the same manner the second wheel, by turning six times, turns the third wheel, *h*, once; the first wheel therefore turns thirty-six times for one turn of the last; and as the diameter of the wheel *c*, to which the power is applied, is three times greater than that of the axle, which has the resistance, three times 36, or 108, is the difference of velocity:—therefore 1 pound at *b* will balance 108 pounds at *a*.

On the principle of combined wheels, cranes are made, by which one man can lift many tons. It is even possible to make an engine, by means of which a little windmill, of a few inches in diameter, could tear up the strongest oak by the roots; but of course this would require a long time for its work. The most familiar instances of wheel-work are in our clocks and watches. One turn of the axle on which the watch-key is fixed, is rendered equivalent, by the train of wheels, to about 400 turns, or beats, of the balance-wheel; and thus the exertion, during a few seconds, of the hand which winds it up, gives motion for 24 or 30 hours. By increasing the number of wheels, time-pieces are made which go for a year; and if the material would last, they might easily be made to go for a thousand years.



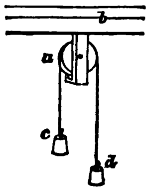
THE INCLINED PLANE is described by the above cut. A force pushing a weight from C to D, only raises it through the perpendicular height, E D, by acting along the whole length of the plane, C D; and if the plane be twice as long as it is high, one pound at B, acting over the pulley, D, would balance two pounds at A, or any where on the plane; and so of all other quantities and proportions. A horse drawing on a road where there is a rise of one foot in twenty, is really *lifting* one twentieth of his load, as well as overcoming the friction and other resistance of the carriage. Hence

the importance of making roads as level as possible; and hence the error, which has often been committed, of carrying roads directly over hills, for the sake of straightness, when, by going round the bases of the hills, the distance would scarcely have been increased, and all rising and falling would have been avoided. Hence, also, a road up a very steep hill must be made to wind, or go zigzag, all the way; for, to reach a given height, the ease of the pull to the horses is greater, exactly as the road is made longer. An intelligent driver, in ascending a steep hill by a broad road, winds from side to side all the way, to save his horses what little he can.

Hogsheads of merchandise, which twenty men could not lift by applying their strength directly, are often seen moved out of, or into, wagons by one or two men who have the assistance of inclined planes. On some canals and railroads, the loaded boats and cars are drawn up by machinery on inclined planes. It is supposed that the ancient Egyptians must have used this mechanical power to assist in elevating and placing those immense masses of stone with which their pyramids and other gigantic piles of architecture were constructed.

In our speculations upon the power of the inclined plane, we suppose the plane to be perfectly smooth, and that bodies move upon it without friction or impediment; but this can never be the case in practice, even in the most perfect machines; consequently, some allowance must be made from the calculated effect, and when carriages move upon rough or sandy roads, this allowance must be considerable.

THE PULLEY. A pulley is a grooved wheel, around which a rope is passed, and is either fixed or movable.

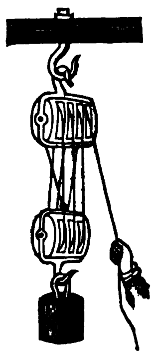


The preceding cut represents a fixed pulley, which never changes its position : *a* is the wheel ; *b* a beam, or roof, from which the wheel is suspended ; *c* is the power hanging at one end of the rope ; and *d* is the weight at the other end. In such a construction, it is evident that the weight — for instance, ten pounds — is equally supported by each end of the rope, and that a man holding up one end, only bears half of it, or five pounds ; but to raise the weight one foot, he must draw up two feet of rope ; therefore, with the pulley, he lifts five pounds two feet, when he would be obliged to lift ten pounds one foot without the pulley.

This kind of pulley, however, possesses no mechanical advantage. To raise a pound weight from the ground at one end of the cord, the power of one pound must be exerted at the other. Its object, then, is not to save power, but to give convenience in pulling. For instance, by pulling downwards, a weight may be raised upwards ; or, by pulling in one direction, a load may be made to proceed in another. Thus, in drawing a bucket out of a well, it is much easier to pull downwards, by means of a rope passing through a pulley

over the head, than upwards, by drawing directly at the bucket.

Many wheels may be combined together, and in many ways, to form compound pulleys. Wherever there is but one rope running through the whole, as

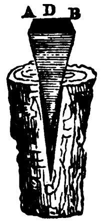


shown here, the relation of power and resistance is known by the number of folds, or turns, of the rope which supports the weight. Here are six turns, and a power of one hundred pounds would balance a resistance of six hundred. The chief use of this pulley is on board ships, where it is called a *block*. It aids so powerfully in hoisting the masts and sails, &c., that, by means of it, a small number of sailors are rendered equal to the duties of a large ship.

There is no assignable limit to the power which may be exerted by means of pulleys. A machine may be constructed to raise with ease any weight which the strength of the materials will bear, provided the com-

bination be not so complex as to exhaust the power by the friction produced.

THE WEDGE. This power acts on the principle of an inclined-plane force moving forward between resistances, to overcome or separate them, instead of being stationary, while the resistance is moved along its surface. The same rule, as to mechanical advantage, has

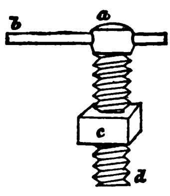


been applied to both cases, the force acting on the wedge being considered as moving through a space equal to its length, C D, and the resistance as yielding through a space equal to its breadth, A B. But this rule is far from explaining the extraordinary power of the wedge. It appears that, during the tremor produced by the blow of the driving-hammer, the wedge insinuates itself, and advances much more quickly than the above rule anticipates. The wedge is used for many purposes, as for splitting blocks of stone and wood; for squeezing strongly, as in the oil-press; for lifting great weights, as when a ship of war, in dock, is raised by driving wedges under her keel. An engineer in London, who had built a very lofty and heavy chimney for his steam-engines and furnaces, found, after a time,

that it was beginning to lean on one side. By driving wedges under that side, he succeeded in restoring it to a complete perpendicular.

The wedge is the least used of the simple mechanical powers, but the principle upon which it acts is in extensive application. Needles, awls, bodkins, and driving nails, are the most common examples. Knives, swords, razors, the axe, chisel, and other cutting instruments, also act on the principle of the wedge; so likewise does the saw, the teeth of which are small wedges, and act by being drawn along while pressed against the object operated upon. When the edge of a scythe, or razor, is examined with a microscope, it is seen to be a series of small, sharp angularities, of the nature of the teeth of a saw.

THE SCREW may be considered as a winding wedge; for it has the same relation to a straight wedge that a road, winding up a hill or town, has to a straight road of the same length and acclivity. A screw may be



described as a spindle, *a d*, with a thread wound spirally round it, turning or working in a nut, *c*, which has a corresponding spiral furrow fitted to receive the thread. Every turn of the screw carries it forward in a fixed nut, or draws a movable nut along upon it, by exactly

the distance between two turns of its thread; this distance, therefore, is the space described by the resistance, while the force moves in the circumference of the circle described by the handle of the screw, as at *b*, in the figure. The disparity between these lengths, or spaces, is often as a hundred, or more, to one; hence the prodigious effects which a screw enables a small force to produce. Screws are much used in presses of all kinds; as in those for squeezing oil and juice from vegetable bodies, as linseed, rape-seed, almonds, apples, grapes, sugar-cane, &c. They are used in the cotton-press, which reduces a great spongy bale, of which a few, comparatively, would fill a ship, to a dense package heavy enough to sink in water; and in the common printing-press, which forces the paper strongly against the types. The screw is the great agent in the coining machinery of mints.

As a screw can easily be made with a hundred turns of its thread in the space of an inch, and at perfectly equal distances from each other, it enables the mathematical instrument maker to mark divisions on his work with a minuteness and accuracy quite extraordinary. When a screw is at liberty to move equally in all directions, it is simply called a *screw;* but when it is confined at its ends, so that it can merely revolve, without advancing or withdrawing, it is called an *endless screw*,—and in this case it generally acts into the teeth of a wheel, either to move or be moved by that wheel; but its power is alike in both cases. The screw, though a mechanical power, can hardly be called a simple instrument, because, from its great friction, it always requires the assistance of a lever to turn it; and when

so turned, its power is estimated by taking its circumference, and dividing this by the distance between any two of its threads.

Yet, after all, there seems to be no reason, except long-established usage, why the appellation of Mechanical Powers should be restricted to the six contrivances above explained; for many others equally deserve it; and, in fact, the mightiest of all mechanical devices, the steam engine, does not derive its power from solid substances at all.

HYDROSTATICS.

THIS science has for its object the examination of the mechanical laws which regulate the motions, pressure, gravitation, and equilibrium, of inelastic fluids, as well as their effects upon bodies which float upon or are immersed in them. The construction of pumps and machines for raising and conveying water, and of machinery to be moved by it, is made a separate branch of the same inquiry, under the name of HYDRAULICS, which will be the subject of the next chapter.

The incompressibility of water had long been suspected, but was first fairly put to the test in the Academy del Cimento at Florence, in 1650. A quantity of pure water was introduced into a hollow sphere of gold, as being the most dense and compact metal, and a screw, working in a water-tight joint, was then forced into the globe among the water, by which it was compressed with great force; and it was found that the water refused to admit of this compression, but actually oozed through the pores of the metal, and appeared like dew on the outside of the globe. This process is called the *Florentine experiment.*

Mr. Canton afterwards repeated this experiment in a very accurate manner, and with some variation of form. He enclosed a quantity of mercury in a glass

tube similar to those used for thermometers, but of greater dimensions, and he observed to what point the mercury rose when the whole was heated to 50 degrees of Fahrenheit: after this, the mercury was made to expand, by increased heat, until the whole tube was filled, and in this state its end was hermetically sealed. The mercury, being thus relieved from the pressure of the atmosphere, did not fall down to its original situation, but stood nearly a third of an inch higher than before, by which mercury was proved to be an expansible, and consequently a compressible, fluid. The tube was now emptied; and water which had been long boiled, to clear it from any air which it might contain, was substituted in the place of mercury, and treated in the same manner. The water was found to stand nearly half an inch higher, when relieved from atmospheric pressure, than it did before; from which it was inferred that water is slightly compressible, though to so small a degree as to be of no consequence in practice.

This experiment, however, was on a very small scale, and nothing further was done towards ascertaining the degree of condensation that water would admit of, till Mr. Perkins, an American, tried some very ingenious and decisive experiments upon it. He was first led to the subject by the contemplation of a simple, but hitherto unexplained fact; namely, that, when a bottle, completely filled with water, well corked and secured, was sunk into the deep sea by a heavy weight, it always returned again to the surface, either with the cork pushed into the inside, or protruded in a greater or less degree; but the water in the bottle was, in all cases,

turned from fresh to salt. Mr. Perkins, therefore, tried several experiments of this sort with cylinders of brass and iron, constructed for the purpose. The result of these trials established the fact of the compressibility of water in the most satisfactory manner. 30,000 pounds pressure to the inch will lessen its bulk one twelfth.

Fluids have weight, and gravitate towards the earth, according to their density, in the same way that solids do; but, from the want of cohesion among their particles, they are incapable of assuming any particular form without assistance, and, consequently, they always take the shape of the vessel which contains them. They also exert a certain force against the sides of that vessel, from their tendency to fall, which constitutes their lateral pressure; for fluids not only press downwards with their whole might, in obedience to gravitation, but they press sideways, or laterally, in all directions at the same time, and from the same cause; and consequently, no fluid can remain in a state of quiet equilibrium unless every part of its surface is equidistant from the centre of the earth, or in what is generally called a *level plane*, though that apparent plane is, in fact, not a plane, but partakes of the convexity of the earth. And it is for the purpose of establishing such an equilibrium that fluids always run from a higher to a lower situation.

For the purpose of explaining the manner in which the surfaces of fluids become level, it may be very fairly supposed that the particles of which they are composed are placed one upon another, so as to form what may be termed pillars or columns of particles; and supposing all the particles to be of the same size

and weight, the columns on one side of the vessel will be an exact balance to those on the other side. The cause of bodies floating upon fluids, or sinking in them, may be explained the same way; for, whenever a solid is immersed in a fluid, it displaces a quantity of water, and consequently renders the columns of particles underneath it shorter, and, therefore, lighter, than those which surround it. But the weight of the floating body becomes a counterpoise to the greater length of the surrounding columns, and must in every case be precisely equal to the quantity of water which it displaces. Consequently, all things which are lighter than their own bulk of water will swim, and all that are heavier must sink. A ship, therefore, of 500 tons' burden must displace 500 tons of water from the bed, or hollow, which it makes from the keel up to the water line; and in this way the actual tonnage of a ship is estimated, although her nominal burden is fixed by another species of measurement.

The truth of this position is very satisfactorily proved by putting the model of a ship into a scale, and exactly balancing it with water in the other scale. The ship is then removed, and placed in a small cistern quite filled with water, when a quantity of it will flow over, and, on taking the ship out, it will be found that the vacuity will be exactly filled by the water in the scale, being the *weight* of the floating body.

Notwithstanding the above experiments seem to prove that the pressures of fluids are in consequence of a mechanical equilibrium, dependent upon the gravitation of equal quantities of matter acting against each other, yet, on more mature examination, it is

found that such pressures are regulated by perpendicular height, and the area of the surface acted upon, without any regard to quantity, or absolute gravity. For, although a pound of water can, in itself, produce no greater effect than is due to a pound, yet, from the properties of fluids, it may be so disposed as to produce the effect of many hundred pounds. This has obtained the name of the *hydrostatic paradox.* The bottom of a vessel bears a pressure proportional to the height of the liquid; so likewise do those parts of the sides which are contiguous to the bottom, because the pressure of fluids is equal every way. Thus the sides of a vessel must every where sustain a pressure proportional to their distance from the upper surface of the liquid; whence it follows that, in a vessel full of a liquid, the sides bear the greatest stress in those parts next the bottom, and the stress upon the sides decreases with the increase of the distance from the bottom, and in the same proportion; so that, in vessels of considerable height, the lower parts ought to be much stronger than the upper. This has been illustrated by a striking experiment. A strong, though small, tube of tin, twenty feet high, was inserted in the bung-hole of a hogshead: water was poured in till it rose within a foot of the top of the tube; the hogshead then burst, and the water was scattered about with incredible force.

The running, or spouting of fluids, from the sides of vessels, arises, likewise, from lateral pressure, and is, consequently, influenced by the height of the column, without regard to the quantity it contains: consequently, if any given quantity of water issues in a certain time

from a hole in a cask, or reservoir, double that quantity will issue from another hole, of precisely the same dimensions, if it be situated four times as deep as the first, below the surface of the fluid. A similar hole, nine times as deep, will deliver three times as much fluid in the same time. The discharge is, therefore, as the square root of the depth beneath the surface; which law is of great importance in the practical construction and arrangement of water-works, and, if not attended to, may occasion a great waste of power.

From the principles already advanced, it follows that a stream will always rise as high as its fountain-head: that is, if a tube, twenty miles long, and rising and descending among the inequalities of the land, were nearly filled with water, and could have its ends brought together for comparison, it would exhibit two liquid surfaces, having precisely the same level, and, on either end being raised, the fluid would sink in it, to rise in the other. If there were two lakes, on adjoining hills, of different heights, a pipe of communication descending across the valley, and connecting them, would soon bring them to the same level; or, if one were much lower than the other, it would empty the latter into the former. The ancient method of supplying cities with water was by means of aqueducts, or bridges, built over the valleys, and supporting either pipes, or a conduit, or channel. These stupendous and costly erections, the remains of which still adorn the ruins of ancient cities, are supposed to have owed their origin to an ignorance of the above principle of hydrostatics; but it is quite as probable that the ancients were compelled to erect these structures by the practical difficulty

of uniting a long range of pipes in such a manner as to remain perfectly water-tight against the pressure of a heavy column of water. This is not easy even in the present improved state of the mechanic arts, and with all the advantage of cast-iron and the most durable materials, instead of stone and earthenware, which appear to have been chiefly used for pipes in the construction of the older water-works. Even at the present day, it is found more convenient to conduct water to cities, from long distances, by open aqueducts than by pipes, as has been done at New York. Here the purest water is conveyed from the River Croton, which is forty-one miles from the city, to a reservoir which will hold 150,000,000 gallons. From this reservoir, it is carried by pipes to all parts of the city, in sufficient quantities to supply every demand for it, for domestic uses, for watering streets, and extinguishing fires.

What has been said upon water-works equally applies to fountains; for a jet can be produced only by the effort of water to rise to its level, or by its being under the influence of condensed air, or some other force. Thus, if an elevated cistern, or reservoir, be kept supplied with water, and a tube descends from its lower part, ending in a small orifice pointing upwards, the water will spout from it, and form a jet nearly equal in height to that of the water from which it is supplied; but, for want of that support which the fluid derives from the sides of a tube, or close vessel, and from its being in constant and rapid motion through the resisting air, it will never gain the full height of the column of supply.

Since the weight which a body loses, when immersed

in a fluid, is always the weight of as much of that fluid as is equal in bulk to itself, it follows that the weight lost by the body cannot at all depend either on the depth of the fluid itself, or the depth to which the body is immersed. An anchor loses no more of its weight when it is at the bottom, than when it is just below the surface; for in both cases it loses the weight of as much water as is equal in bulk to itself. It is not easier to swim in deep than in shallow water; for whatever is the depth, a man loses the weight of as much water as is equal in bulk to his own body; for which reason, shallow water will buoy him up with as great force as deep water. Indeed, it is easier to swim in the sea than in a river, because salt water is specifically heavier than fresh. In the Dead Sea, the water of which is more deeply saturated with salt than any other body of water in the world, this principle is strikingly illustrated. In the Travels of Mr. Stephens is the following account of his attempting to swim in this lake: "I know, in reference to my own specific gravity, that, in the Atlantic or Mediterranean, I cannot float without some little movement of the hands, and even then, my body is almost totally submerged; but here, when I threw myself upon my back, my body was half out of water. It was an exertion even for my lank Arabs to keep themselves under. When I struck out, in swimming, it was exceedingly awkward; for my legs were constantly rising to the surface, and even above the water. I could have lain there and read, with perfect ease. In fact, I could have slept."

There are few, if any, animals that are specifically heavier than common water. The substances, indeed,

of both animals and vegetables, are specifically heavier; the floating of either is, therefore, to be attributed to the cells, or receptacles, interspersed within them, which are filled with air, oil, and substances lighter; so that, taken together, they form a mass specifically lighter than common water. Thus the bulk of the body is increased by distending the chest in inspiration; this has been tried by an experiment on a fat man, of an ordinary size, by finding what weight he could support, so as to have the top of the head just above water. When his lungs were full of air, he was found to rise with fourteen pounds of lead; but on breathing out the air, he could sustain only eleven pounds.

To show the practical purposes the principle here illustrated may serve, we will relate the story of Hiero's crown. Hiero, king of Syracuse, had delivered a certain weight of gold to a workman, to be made into a crown; the latter brought back a crown of the proper weight, which was afterwards suspected to be alloyed with silver. The king applied to the celebrated mathematician, Archimedes, to know how he might detect the cheat, the difficulty being to measure the bulk of the crown, without melting it into a regular figure: silver being, weight for weight, of greater bulk than gold, any alloy of the former, in place of an equal weight of the latter, would mechanically increase the bulk of the crown. Archimedes was at first embarrassed with this problem; but one day, on going into a bath, which happened to be quite filled with water, he was struck with the simple fact that a quantity of water, of the same bulk as his body, must flow over before he

could immerse himself. It immediately occurred to him that, by immersing a weight of pure gold, equal to that which the crown ought to have contained, in a vessel full of water, and observing how much water was left when the gold was taken out, and by afterwards doing the same thing with the crown itself, he could ascertain whether the latter exceeded the former in bulk. The moment he was struck with this thought, his exultation was so great that he leaped out of the bath, and, without stopping to put on his clothes, ran home, crying out, "*Eureka!*" "I have found it!" an expression which has become proverbial.

HYDRAULICS.

Water, as we have already remarked, may be made a useful agent of power, merely by allowing it to act with the force of its own gravity, as in turning a mill; and in this manner it is extensively employed in all civilized countries possessing streams which are suf-

ficiently rapid in their descent. But water may be rendered otherwise useful as an agent of force in the arts. Although subtile in substance, and eluding the grasp of those who attempt to handle it, water can, without alteration of temperature, be made to act, as a mechanical power, as conveniently and usefully as if it were a solid substance, like iron, stone, or wood. The lever, the screw, the inclined plane, or any of the ordinary mechanical powers, are not more remarkable as instruments of force than water, a single gallon of which may be made to perform what cannot be accomplished, except at enormous cost and labor, by the strongest metal.

To render water serviceable as an instrument of force, it must be confined, and an attempt then be made to compress it into less than its natural bulk. In making this attempt, the impressed force is freely communicated through the mass, and, in the endeavor to avoid compression, the liquid will repel whatever movable object is presented to it. The force with which water may be squirted from a boy's syringe gives but a feeble idea of the power of liquids, when subjected, in a state of confinement, to the impression of external force.

We have already spoken of the tendency of water to seek every where a common level, on the principle of which aqueducts are constructed. Springs in the ground are natural hydraulic operations, and are accounted for on principles connected with the laws of fluids. One class of springs is caused by capillary attraction, or natural attractive forces, by which liquids rise in small tubes, porous substances, or between flat

bodies, closely laid together. This species of power is a remarkable variety of the mutual attraction of matter, and is as unaccountable as the attraction of gravitation, or the attraction exercised by the load-stone. Springs from capillary attraction are believed to be less common, and of less importance, than springs which originate from the obvious cause of water finding its level. The water which falls in the form of rain sinks into the ground in high situations, and finds an outlet at a lower level, though perhaps at a considerable distance.

The friction, or resistance, which fluids suffer when passing through pipes, is much greater than might be expected. It depends chiefly upon the particles being constantly driven from their direct course by the irregularities in the surface of the pipe. An inch tube, of 200 feet in length, placed horizontally, is found to discharge only a fourth part of the water which escapes by a simple aperture. Air, likewise, in passing through tubes, is retarded, as was discovered by a person who constructed a great bellows at a waterfall, to blow a furnace two miles off. This resistance is so great, that when it was first proposed to lay gas-pipes in England, some engineers were of opinion that the gas could not be forced through them. All liquids flow faster through an orifice, or pipe, the higher their temperature is kept, as this diminishes that cohesion of parts which exists, to a certain degree, in all of them, and affects so much their internal movements. The flux of water through orifices, under uniform circumstances, is so regular, that, before the invention of clocks and watches, it was employed as a means of measuring time. These

water-clocks were called *clepsydræ*, and were often used by ancient orators, to show them when the time allotted to them for speaking had expired. The common hour-glass of running sand is another modification of the same principle.

The progress of water, in an open conduit, such as the channel of a river, or an aqueduct, is influenced by friction in the same manner. But for this, and the effect of bending, a river, like the Rhone, drawing its waters from an elevation of a thousand feet above the level of the ocean, would pour them out with the velocity of water issuing from the bottom of a reservoir a thousand feet deep; that is to say, at the rate of 170 miles an hour. The ordinary flow of rivers is about 3 miles an hour, and their channels slope three or four inches a mile. Three feet fall, a mile, makes a mountain torrent. The friction of water, moving in water, is such, that a small stream directed through a pool, and rapid enough to rise over the opposite bank, will soon empty the pool. Large fenny tracts have been drained in this manner. The friction between air and water is also singularly strong, as is proved, on a great scale, by the magnitude of the ocean waves which are caused by it. A little oil, thrown upon the surface of the water, spreads as a thin film all over it, and defends it from further contact and friction of air. If this is done at the windward side of a pond, where the waves begin, the whole surface will soon become as smooth as glass; and even out at sea, where the commencement of the waves cannot be reached, oil thrown upon them smooths their surface, and prevents their curling over and breaking.

A stone thrown into a smooth pond causes a succession of circular waves to spread from the spot where it falls. They become of less elevation as they expand, and each new one is less raised than the preceding, so that gradually the liquid mirror is again as perfect as before. Several stones falling at the same time in different places cause crossing circles, which, however, do not check the progress of each other — a phenomenon seen in beautiful miniature at each leap of the little insects which cover the surfaces of ponds in the calm days of summer. Such waves are caused in this manner: When the stone falls into the water, because the liquid is incompressible, a part of it is displaced laterally, and becomes an elevation, or circular wave, around the stone; this wave then falls downward and outward, in obedience to the laws of fluidity, and the circle is seen to spread. In the meantime, where the stone descended, a hollow is left for a moment in the water, but, owing to the surrounding pressure, it is soon filled up by a sudden rush from below. The rising water does not stop, however, at the exact level of that around, but, like a pendulum, sweeping past the centre of its arc, it rises as far above the level as the depression was deep. This central elevation now acts as the stone did originally, and causes a second wave, which pursues the first, and, when the centre subsides, like the pendulum still, it sinks again as much below the level as it had mounted above; hence it must again rise, again to fall, and this for many times, sending forth a new wave at each alternation. Owing to the friction among the particles of

water, each new wave is less raised than the preceding, and at last the appearance dies away.

The common cause of waves is the friction of the wind upon the surface of the water. Little ridges, or elevations, first appear, which, by the continuance of the force, gradually increase till they become rolling billows. The heaving of the Bay of Biscay, or, still more remarkably, that of the open ocean between the southern capes of America and Africa, exhibits one extreme, and the stillness of the tropical seas, which are sheltered by encircling land, exhibits the other. In sailing round the Cape of Good Hope, waves are met with so vast, that a few ridges and depressions occupy the extent of a mile. But these are not so dangerous to a ship as a shorter sea, with more perpendicular waves. The slope in the former is so gentle, that the rising and falling are scarcely felt, while the latter, causing an abrupt and violent pitching of the vessel, are often destructive. The unfortunate steam-ship President doubtless perished from this cause. She encountered a tremendous gale on the day after leaving New York, and, during the height of its fury, she must have been at a point where the Gulf Stream approaches the shoal called George's Bank, and causes an almost perpendicular surge of the most dangerous character. The ship was last seen struggling ahead directly against the sea, and pitching violently. Her enormous length must have greatly added to the danger, and probably caused her soon to rack to pieces.

The velocity of waves is in proportion to their magnitude. The largest waves move from thirty to forty

miles an hour. It is a vulgar belief that the water itself advances with the speed of the wave, whereas it is only the *form* that advances, while the substance, with the exception of a little spray above it, remains rising and falling in the same place, with the regularity of a pendulum. A wave of water, in this respect, is exactly imitated by the wave running along a stretched rope when one end is shaken, or by the mimic waves of our theatres, which are generally undulations of cloth shaken up and down. But when a wave reaches a shoal, or beach, the water becomes really progressive, because then, as it cannot sink directly downwards, it falls over and forwards, seeking its level.

So terrific is the spectacle of a storm at sea, that it is generally viewed through a medium which biases the judgment; and, lofty as waves really are, imagination pictures them loftier still. Now, no wave rises more than ten feet above the ordinary sea level, which, with the ten feet that it afterwards descends below it, give twenty feet, from the hollow, or *trough*, of the sea, as the sailors call it, to the adjoining summit. The spray of the sea, driven along by the violence of the wind, is, of course, much higher than the crest of the wave, and a wave coming against an obstacle may dash to a great elevation above it. At the Eddystone lighthouse, in the English Channel, in heavy storms, the waves dash over the top of the lantern.

On a superficial view of the doctrine of resistance, in the case of bodies moving through a fluid, many persons would conclude that, if a body moving through the water at a given rate, meets a given resistance, it should encounter double that resistance when moving

at double the rate ; but this is a fallacy ; the resistance is four times greater with a double rate. The reason is very clear. A boat which moves one mile an hour displaces a certain quantity of water, and with a certain velocity; if it moves twice as fast, it of course displaces twice as many particles in the same time, and requires to be moved with twice the force on that account. But it also displaces every particle with a double velocity, and requires another doubling of the power on this account; the power therefore, being doubled on two accounts, becomes a power of four. In the same manner, with a triple speed, three times as many particles are moved, and each particle with a triple velocity; therefore, a force of nine must be applied to overcome the resistance. For a speed of four, sixteen is wanted, and so on. Thus, even if the resistance against the bow of the vessel only were considered, one hundred horses would drag a canal-boat only ten times faster than one horse. But there is another important element in the calculation — namely, the lessening of the usual water-pressure on the stern of the vessel as she moves forward, on account of which, the force required to produce an increased velocity is still greater than what is shown by the above calculation.

There is not a more important truth in physics than this ; it explains so many phenomena of nature, and becomes a guide in so many matters of art. It explains in what manner so great an expenditure of fuel is required to obtain high velocities in steamboats. It shows the folly of crowding sail upon a ship with a strong breeze, the trifling advantage in point of speed

by no means compensating for the wear of the sails and the risk of accidents. No seamen practise this so much as the Americans, who are ready to incur any degree of expense, and run any risk, in the hope of gaining a little time. We remember an instance where a Boston merchant said to one of his shipmasters about to sail, "Wear out what you please, but make a quick passage."—This ship returned from Europe, having worn out an entire new set of sails in one voyage. The above law explains, also, why a ship glides through the water one or two miles an hour with very little wind, although, with a powerful breeze, she would sail only eight or ten. Less than the 100th part of that force of wind which drives her ten miles an hour will drive her one mile; and less than the 400th part will drive her half a mile. Thus, also, during a calm, a few men pulling in a boat can tow a large ship.

If a ship be anchored in a stream where the current is four miles an hour, the strain on her cable is not one fourth part so great as if the current were eight miles. The rapid increase of resistance, in proportion to the increase of velocity, shows that we soon reach the maximum of speed in ships. Fifteen miles an hour is the utmost that a ship can sail. No fish swims faster than twenty miles an hour. The flight of birds, also, has a limited celerity; but as the thin air opposes much less resistance than water, flying is, of course, more rapid than sailing or swimming. The crow, when flying homeward against the storm, cannot face the wind in the open sky, but skims along the surface of the earth in deep valleys, and wherever the swiftness of the wind is retarded by terrestrial obstacles.

The great albatross can stem upon the wing the current of a gale, keeping company with a driving ship when the wind is passing at the rate of a hundred miles an hour; but perhaps this is the limit to which winged speed can reach.

If a flat surface experience a certain resistance, a projecting surface, like that of a ball or wedge, is resisted in a less degree. The explanation is, that a flat surface throws the particles of fluid almost directly outwards from its centre to its circumference; but the convex or wedge-like surface, while displacing them just as far, does it more slowly, and therefore with less expenditure of force in proportion as its point is in advance of its shoulder, or broadest part. The shape of the hinder part of a solid moving through a fluid is of importance, for corresponding reasons. Fishes are wedge-like both before and behind: so are birds, and they stretch out their necks while flying, so as to become like sharp points dividing the air. In the form of the under part of boats and ships, men have imitated the shape of fishes. There are boats used by the Chinese called *snake-boats*, which are only a foot or two in width, but a hundred feet long, and when rowed, as they often are, by a hundred oars, their swiftness is excessive. Oars for boats are made flat, and often a little concave, that the mutual action between them and water may be as great as possible. The webbed feet of water-fowl are oars; in advancing, they collapse, like a shutting umbrella, but open outwards in the thrust backward, so as to offer a broad concave surface to the water. The expanded wings of birds are, in like manner. a little concave towards the air

which they strike. The sails of ships, when they are receiving a fair wind, are left slack, so as to swell and become hollow.

We conclude this topic by the following striking example of the power of water, given by Mr. Olmstead: "A waterfall like that of Niagara, where an immense body of water rolls first in rapids down a long inclined plane, and then descends perpendicularly from a great height, affords one of the greatest exhibitions of mechanical power ever seen. The Falls of Niagara contain power enough to turn all the mills and machines in the world. They waste a greater amount of power every minute than was expended in building the pyramids of Egypt; for, in that short space of time, millions of pounds of water go over the falls, and each pound, by the velocity it gains in first falling down the rapids, and then perpendicularly, acquires resistless energy. Water falling one hundred feet would strike on every square foot with a force of more than six thousand pounds."

PNEUMATICS;

OR,

THE MECHANICAL PROPERTIES OF AIR.

THE earth which we inhabit is entirely enveloped, or surrounded, by a thin, transparent, and invisible fluid, called *air*. This air, together with the various gases, steams, vapors, and exhalations that are constantly thrown into it, and which form clouds, is called by the general name of the *atmosphere*. Consequently, atmospheric air is of a very mixed nature; but when pure, it is found, by chemical examination, to consist of two permanently elastic gases, or airs, called *nitrogen*

and *oxygen*, as we shall hereafter show in our chapter on Chemistry.

Air, though invisible, is a material substance, and partakes of all the properties which belong in common to other matter; for it occupies space, attracts and is attracted, and, consequently, has weight. It likewise partakes of the nature of fluids, for it adapts itself to the form of the vessel which contains it; and it presses equally in all directions; consequently, it must be considered as a material fluid. But, inasmuch as it is highly elastic, a property which is common to all gases, steams, and vapors, while the more visible and tangible fluids, such as water, oil, spirits, &c., possess this character in a very slight degree, if at all, so they require a separate examination.

The various airs, or gases, are called *permanently elastic*, because, under all changes which can be wrought upon them, they maintain their characters of fluidity and elasticity, and will not admit of being congealed, or rendered solid. With steams and vapors, the case is very different; for they arise from inelastic fluids by the application of heat, and they are highly elastic so long as they retain their form of vapor; but on being cooled, they return again to their original state of inelastic fluid, and therefore differ very materially from air, and cannot be said to be permanently elastic. Water affords a very good instance, for this is inelastic; but its steam is elastic in the highest degree; whenever this steam becomes cooled, it reverts back into its original state of water, and of course resumes all its former characters.

Since air has weight, and every thing upon the earth

is surrounded by it, it follows that all things must be subject to the pressure which will be exerted, not only upon them, but upon itself; and since air is elastic, or capable of yielding to pressure, so, of course, the lower part of the atmosphere will be more dense, or in a state of greater compression, than that which is above. Suppose, for example, that the whole height of the atmosphere is divided into 100 equal parts, and that each of these may weigh an ounce, or may be equivalent to the production of that pressure; then the earth, and all things upon its surface, will be pressed with the whole 100 ounces; the lowest stratum of air will be pressed by the 99 ounces above it, the next by 98, and so on till we arrive at the 99th stratum from the bottom, which will, of course, be subject to no more than one ounce of pressure.

Springs of metal, or wood, expand or contract, until they arrive at a state of equilibrium with the force that is acting upon them. The air acts in the same way; for, being of an elastic nature, it will, of course, yield to any force that may be impressed upon it, until its spring becomes a balance to that force. It is on this account alone that we are insensible of the air's pressure; for, notwithstanding the body of a man of ordinary stature is calculated to sustain no less a pressure of air than 32,400 pounds, yet the spring of the air contained within the body exactly balances, or counteracts, the pressure from without, and makes him insensible of the existence of any pressure at all. The spring and pressure of air will thus balance each other in all cases, except when the communication is cut off, and the natural equilibrium is destroyed by some disturbing cause.

The air-pump is the instrument that is generally used for the destruction of this equilibrium; for, by means of this machine, the air may be taken from the interior of vessels which are put upon its plate, and then the effects of the external and undisturbed air immediately begin to show themselves. Thus, for example, if a small glass receiver, which is open both above and below, be placed upon the plate of an air-pump, and the palm of the hand be put upon it, so as to cover it completely, without leaving any orifice for the admission of the external air, — as soon as the pump is set in motion, the hand will be forcibly held down to the receiver, and cannot be released without difficulty; for the air within the glass being rarefied or diminished in quantity, that without will preponderate by its weight, which keeps the hand down, while the spring of that air which is contained in the hand will cause its lower side to swell, and enter the glass to a considerable depth. This shows the necessity of having all glasses, to be used upon the air-pump, with hemispherical or rounded tops, that they may present a dome, or arched form, to the pressure of the external air; and all such glasses are called by the general name of *receivers.* If an open-topped receiver be covered with a piece of flat glass, the pressure from without will break it.

If a small portion of the shell of an egg be broken away at the small end, and it is then placed under a receiver, and the air is exhausted, the bubble of air that is always contained in the large end will expand, and force out the contents of the egg. A withered apple, placed under a receiver, will expand, and appear fresh, provided its skin be not broken. That air is

contained in water appears plain from the following experiment: Place a tumbler of clear water, in which not a single bubble of air is visible, under a receiver, and then exhaust it; the water will instantly appear full of bubbles, which become large, and rise to the top; but as soon as the air is returned into the receiver, they are all instantly compressed, and disappear.

The ascent of water in a common pump is caused by atmospheric pressure; for the water in the pump being raised by the action of the upper pump-box, a vacuum is created below, which is immediately filled by the pressure of the air from without, which forces the water in the bottom of the well upward, to supply that vacuum. But, as equal weights must, of course, exactly balance each other, and as the weight of the atmosphere is limited, it is evident that only a column of water of a certain height can be raised by that weight. Accordingly, it has been found that water cannot be raised in a pump, by the mere pressure of the external air, higher than 32 or 33 feet; whence the inference is plain, that a column of water of this height is exactly equal in weight to that of the atmosphere on the same surface. The diameter of the column of water, in this case, is of no consequence; because, whatever it may be, an equal-sized column of air always acts against it.

This balance of power between a perpendicular column of water and atmospheric pressure was first observed by Galileo, in erecting a pump for the grand duke of Tuscany; but he appears not to have been aware of its cause. This was first investigated by Torricelli, who made use of quicksilver, a fluid 14

times heavier than water, by which he was enabled to produce a pressure equal to that of water with one fourteenth part of its height, and accordingly, his experiments were very neat and accurate. He filled glass tubes of different sizes, having one end closed with quicksilver; and then, by covering the open end, he inverted them into basins filled with the same metal. Thus he found that the diameters of the tubes had no effect on the experiments, but that all those which were less than 28 inches in height, remained full of quicksilver, when inverted, and that in all those which were taller, the quicksilver descended until it became stationary at between 28 and 31 inches above the surface of that which was in the basin. An empty space was thus left at the upper end of the tube, which has since been found to be the most perfect vacuum producible by art. This is known by the name of the *Torricellian vacuum.*

A tube filled with quicksilver, and thus disposed, is called a *barometer*. In this instrument, the column, being maintained by the pressure of the air, must of course be a balance to that pressure; and if the amount of pressure changes, as it is found to do, then the height of the mercurial column will change also. It is on this account that the quicksilver in the barometer moves up and down through a space of three inches, because the density of the air is never so great as to cause it to sustain the quicksilver at more than 31 inches from the surface of that in the basin below, nor does it ever diminish so as to allow the column to descend lower than 28 inches. The falling of the mercury in the barometer always indicates that a

storm is approaching; for this fall takes place in consequence of the rarefaction of the air, which presently causes the surrounding air to rush in to restore an equilibrium. The barometer thus becomes a most invaluable instrument to the mariner; for on many occasions, when the weather is perfectly serene, and the sky exhibits not the smallest token of approaching bad weather, the mercury is seen to sink with uncommon rapidity. The prudent seaman immediately takes in sail, and makes every preparation against the coming danger. Scarcely has the ship been put into the condition which the sailors emphatically call "snug," when a squall, or perhaps a hurricane, bursts from the sky, and tears away the sails, although furled and secured to the yards, disabling spars and masts, and, but for the timely preparation made against it, would have rendered the ship a complete wreck.

Another useful purpose to which the barometer is made subservient, is to measure the height of mountains; for as the mercurial column is always an exact indication of the pressure produced by the mass of air above its level, the mercury must fall when the instrument is carried from any lower to any higher situation, and the degree of falling must always tell exactly how much air has been left below. When the barometer, on the surface of the earth, stands at 30 inches, and the temperature is 32 Fahrenheit, it has been ascertained, by trial, that taking such a barometer to the perpendicular height of 87 feet lowers the quicksilver just one tenth of an inch. But as the atmosphere decreases in density and weight as we ascend, something more than 87 feet must be ascended, to lower the mercury

another tenth, and so on. By nice calculations of this sort, the system of measurement has been brought to such perfection, that the height of any accessible mountain may be ascertained with the utmost accuracy.

That water is at all times contained in air is evident from the cloud of vapor which we constantly observe to be precipitated whenever a very clear receiver is exhausted upon the air-pump, and which is neither more nor less than a shower of rain in miniature. The damp on our walls and windows, which precedes wet weather, arises from the same cause; for then the air is overcharged with water, and begins to return a part of it: the pressure of water in the atmosphere is detected by the instruments called *hygrometers*, which measure the moisture of the air. They are of various forms, and are constructed of different materials; but, unfortunately, most of them lose their action in course of time. One of the simplest of these instruments may be formed of a considerable length of well-twisted flaxen string, suspended from the ceiling of a room about 4 inches from the wall, and stretched tight by a leaden ball, above which is fixed a circle of pasteboard with divisions upon the edge of it, and a fixed mark on the wall for observing their motion. In wet weather the string twists tighter, and of course turns the circle round, and in dry weather it uncoils. There is a toy called the *weather-house*, constructed on this principle: in this, by the twisting and untwisting of the string, a woman comes out at the door in fine weather, and a man when it is wet. The most common hygrometer, which somewhat resembles a watch

in shape, is made of the beard of a peculiar species of wild oat, which possesses the singular property of coiling up in dry weather, and unfolding when wet. A scale-beam, with any substance capable of absorbing moisture, such as a sponge, at one end, counterpoised by a metal weight at the other, becomes an hygrometer—since the sponge will absorb moisture from the air, and become dry again, by which it is made heavier or lighter than the counterpoising weight.

Air incorporates not only with water, but with a great variety of other volatile materials, by which many of its characters become much changed; and since heat assists in these combinations, so all warm or hot fluids will evaporate more readily than such as are cold. Put a few drops of ether into a large drinking-glass, and cover it with a plate for a few minutes, the ether will evaporate into the air, and will render it so inflammable that it will take fire on the approach of a taper. Notwithstanding the attraction that thus appears to exist between the air and various fluids, yet the very pressure of the atmosphere prevents their rising in vapor, or evaporating, upon a slight increase of temperature. Thus ether is the rarest and most volatile of all the visible fluids; and when a cup containing a little of this is placed under the receiver of an air-pump, a very trifling action of the pump will make it boil. Water in the open air will not boil unless heated to 212 degrees, but when the atmospheric pressure is removed, it boils at a much lower temperature; and a glass of strong ale, when heated in the slightest degree under an exhausted receiver, will put on the appearance of boiling. From these facts it follows that,

on the top of a mountain, water will boil with a less degree of heat than in a lower region; and this has been verified by actual experiment.

From the highly elastic nature of air, there is no limit to its condensation, which may be continued as long as there is strength in machinery to force it. It has been carried to great extent; but, from all the experiments that have been tried, it does not appear that condensation produces any effect on the fluidity, transparency, or other characters, of air. Various machines have been invented for this purpose. The air-gun is the best example of the surprising force which air is capable of exerting when condensed to a considerable degree; for by means of this instrument, bullets may be propelled with a force very nearly equal to that of gunpowder. It is a curious fact, that, although the air-pump is a modern invention, yet the air-gun, which is so nearly allied to it in the construction of its valves and condensing syringe, existed long antecedent to it; it was invented as early as the year 1408. The air-gun of the present day, however, is very different from that of former times, which discharged but one bullet after a long and tedious process of condensation, while it now discharges five or six without any visible diminution of force, and will even act upon a dozen, though with less effect.

The alternate rarefaction and condensation of the atmosphere is the cause of most of the changes of the weather; for thus are produced not only wind and storms, but dew, fog, rain, hail, and snow. The air, being saturated with moisture, lets fall a part of it on any reduction of the temperature: the atmosphere,

which has been heated by the sun during the day, and has received much moisture, lets it fall again during the night, and thus causes the night fogs of certain seasons, which float near the surface of the earth until again acted upon by the beams of the next morning's sun. Fog, when condensed by the combination of the minute particles, forms rain; and rain, when frozen, becomes snow or hail.

The general principles of *aërostation*, or navigating the air in balloons, are so little different from hydrostatics, that the reader may be supposed already to understand them, from what has been said. It is a fact universally known that, when a body is immersed in any fluid, if its weight be less than an equal bulk of that fluid, it will rise to the surface; but if heavier, it will sink; and if equal, it will remain stationary. For this reason smoke ascends into the atmosphere, and heated air into that which is colder. The ascent of the latter is shown in a very easy and satisfactory manner, by bringing a red-hot iron under one of the scales of a balance; the balance is instantly made to ascend; for as soon as the iron is brought under the scale, the hot air, being lighter than that which is colder, moves upward, strikes the scale, and elevates it. Upon this simple principle depends the whole theory of aërostation; for it is the same thing whether we render the air lighter by introducing a quantity of heat into it, or enclosing a quantity of gas, specifically lighter than the common atmosphere, in a certain space; both will ascend, and for the same reason. The power of hot air, in raising weights, may be shown in the following manner. Roll a sheet of paper into a conical form,

and fasten it, by its apex, under the scale of a balance; apply the flame of a candle underneath, and the scale will rise, and will not be brought into an equilibrium with the other, except by a much greater weight than would be imagined by a person who had never seen the experiment.

The first balloon was made by a man ignorant of what he was about to discover. Seeing the clouds float high in the atmosphere, he thought that, if he could make a cloud and enclose it in a bag, it might rise, and carry him with it. Then, erroneously supposing cloud and smoke to be the same, he made a fire of green wood, and placed a great bag over it, with the mouth open. He soon had the joy of finding himself in the possession of a bag-full of smoke, which presently rose to the ceiling of the room; but he understood not that the cause of its rising was the hot, rarefied air within, which, being lighter than the surrounding air, was buoyed up, while the visible part of the smoke, which chiefly engaged his attention, was really heavier than the air, and impeded the ascent of the bag. The hot air or fire balloon was afterwards better understood, and was used by aëronauts, until the more commodious and less dangerous modification, called the *inflammable air balloon*, or *balloon of hydrogen gas*, was substituted. The first aëronautic expeditions astonished the world, and endless speculations were indulged as to the important uses to which the new discovery might be applied; but more mature reflection, and recent trials, have shown that the balloon is interesting chiefly as a philosophical toy, and as having furnished the means of making some observa-

tions in elevated regions of the atmosphere. An aëronaut may rise or descend in the air, by throwing out ballast or letting off gas; but he has no power of producing a lateral motion.

The *diving-bell* is a large, heavy, open-mouthed vessel, which is let down in the water, bottom upwards, with men inside. The enclosed air keeps out the water at first; but as the bell descends, the pressure of the water increasing according to its depth, the air is compressed within the bell, and, at 34 feet depth, it is reduced to half its bulk. The bell is then half full of water, and a person within breathes twice as much air, at an inspiration, as he does at the surface. When men are required to remain long under water, a supply of fresh air is conveyed down by means of a forcing-pump, and the heated and contaminated air, which has served for respiration, and which rises to the top of the bell, is allowed to escape through an opening. Men can work at a distance from the bell, and breathe the air from it, through tubes of communication. These operations are so little hazardous, or uncomfortable, that the wages of submarine labor are very little higher than any other.

OPTICS.

Luminous Insects.

THIS science treats of the phenomena of *light* and *vision.* Of the precise character of light there are various theories, but none which admit of actual dem-

onstration, or proof. By some, it has been described as consisting of very minute particles, which are thrown off from what are called *luminous* bodies, in all directions, and with immense velocity; while others consider it as the effect of an undulation, or vibration, produced by luminous bodies in the thin and elastic medium which is interposed between them and the seat of our vision; this vibration producing an effect upon our organs, which we recognize as light, analogous to the impression of sound upon the ear, caused by the atmosphere. This theory is called the *undulatory* theory of light; and the former one, in which light is supposed to consist of material particles, is called the theory of *emission.* Whatever may be the cause, or absolute nature, of light, we know it is a remarkable property of luminous bodies; that it enables us to see the luminous objects themselves, as well as others; and that its absence produces darkness.

All visible bodies may be divided into two classes—*self-luminous* and *non-luminous.* Under the first head are comprised all those bodies which possess in themselves the property of exciting the sensation of light, or vision; such as the heavenly luminaries, terrestrial flames of all kinds, phosphorescent bodies, and those substances which shine by being heated, or by friction. Under the second class, we recognize such bodies as have not, of themselves, the power of throwing off particles or undulations of light, but which possess the power of reflecting the light which is cast upon them by self-luminous bodies. A non-luminous body may thus, by reflection, receive light from another non-luminous body, and communicate it to a third, and so

on; all reflected light, however, is inferior, in point of brilliancy, to that which comes direct from a self-luminous body. The transmission of light was formerly supposed to be instantaneous; but recent observations have shown that, like sound, it requires a certain time to pass from one place to another, though the velocity of its motion is truly astonishing, as has been manifested in various ways. Astronomers have proved, by observing the eclipses of Jupiter's satellites when that planet is nearest, and when it is farthest, from the earth, that light moves from the sun to the earth, a distance of 95 millions of miles, in seven and a half minutes, or about 200,000 miles during a single vibration of a pendulum! So prodigiously great is this velocity, that, as far as any of the common affairs of life may be concerned, light may be said to be instantaneous in its universal action.

Light proceeds in a straight direction from the luminous body which produces it. The direct shining of the sun, or any other luminous body, is in the form of *rays*, or thin, ethereal lines, each acting independently of the other. No such separation of parts, however, is observable in common circumstances, in consequence of the diffusive properties of our atmosphere. *Seeing* is simply the reception of the direct or reflected ray from an object, by our eye. Until the rays of the sun reach the spot on which we are placed, we are neither conscious of light, nor of the presence of the sun as an object. In the same manner, a candle, being lighted, and exposed in the open country in a dark night, all who are able to see it are within the influence of its rays; but beyond a given distance,

these rays are too weak to produce vision; and all who are in this remote situation cannot see the smallest appearance of the light. Yet the number of rays which proceed even from a common candle is so vast as to be beyond the power of imagination to conceive; for if such a light is visible within a sphere of 4 miles, it follows that, if the whole of that space were surrounded with eyes, each eye would receive the impression of a ray of light. In proportion as light advances from its seat of production, it diminishes in intensity. The ratio of diminution is agreeable to that which governs physical forces; that is, the intensity of the light will diminish as the square of the distance increases, or at the rate of 1, 4, 16, &c. But, in proportion as we lose in intensity, we gain in volume; the light is the weaker the farther it is from the candle, but it fills a wider space.

In discussing the properties of light, it is important to consider the *medium* through which it passes, as air, water, glass, &c. Any parcel of rays passing from a point, is called a *pencil* of rays; the point at which converging rays meet, is called a *focus*. Rays may be *parallel*, *convergent*, or *divergent*, which terms will not require an explanation. The point towards which they tend, but which they are prevented from reaching by some obstacle, is called the *imaginary focus*.

REFRACTION is the bending of rays of light from the course they first pursued. If the rays, after passing through a medium, enter another of different density, perpendicular to its surface, they are not refracted, but proceed through this medium, in their original direction. For instance, if the rays of the sun were to

strike upon the surface of a river at right angles, or perpendicularly to its surface, they would go straight to the bottom, and the line which they pursued in the air would be continued in the water. But if they enter obliquely to the surface of a medium either denser or more rare than what they moved in before, they are made to change their direction in passing through that medium; in other words, they are *refracted*. The mode of refraction depends on the comparative density or rarity of the respective media. If the medium which the rays enter be denser, they move through it in a direction nearer to the perpendicular drawn to its surface. On the contrary, when light passes out of a denser into a rarer medium, it moves in a direction farther from the perpendicular. This refraction is greater or less; that is, the rays are more or less bent, or turned aside, from their course, as the second medium, through which they pass, is more or less dense than the first. To prove this in a satisfactory way, take an upright empty vessel into a darkened room, which admits but a single beam of light obliquely through a hole in the window-shutter. Let the empty vessel stand on the floor a few feet in advance of the window which admits the light, and let it be so arranged that, as the beam of light descends towards the floor, it just passes over the top of the side of the vessel next the window, and strikes the bottom on the side farthest from the window. Let the spot where it falls be marked. Now, on filling the vessel with water, the ray, instead of striking the original spot, will fall considerably nearer the side towards the window. And

if we add a quantity of salt to the vessel of water, so as to form a dense solution, the point where the rays strike the bottom will move still nearer to the window. In like manner, if we draw off the salt water, and supply its place with alcohol, the beam of light will be still more highly refracted; and oil will refract yet more highly than alcohol.

The following simple experiment is well known: Take an empty basin, and place it on a table; then lay a silver dollar at the bottom of the basin, and let the spectator withdraw so far that the brim of the basin hides the dollar. Now, fill the basin with water, and the dollar, though lying unmoved, will come completely into sight. The explanation of this phenomenon is, that the ray of light producing vision in the eye is bent, as it emerges from the water, and has all the effect of conveying our sight round a corner. The refractive power of water is also observable when we thrust a straight stick into it; we see that the stick seems to be bent, and fails in reaching the point which we desired it should. On this account, the aim, by a person not directly over a fish, must be made at a point apparently below it, otherwise the weapon will miss, by striking too high. With regard to the refractive power of transparent substances, or media, the general rule, with certain limitations, is in proportion to the densities of the bodies; it increases, for instance, from the most perfect vacuum which can be formed, through air, fresh water, salt water, glass, and so on. But those substances which contain the most inflammable matter have the highest refractive power. It was from the great refractive powers of the diamond

and water, that Newton, with admirable sagacity, predicted that they contained inflammable principles.

The refraction of rays of light is observable in the case of common window-glass. The two sides of a pane not being perfectly parallel to each other, bodies seen through it appear as if distorted; and as the obliquities in the glass are very various, the distortions are equally grotesque and numerous. Some windows are purposely ground on the surface, to produce universal and minute refraction; and thus so great a confusion is introduced among the rays, that objects are not distinguishable through the glass. When the obliquities on the surface of one side of a piece of glass stand distinct from each other, so as to admit of refraction in a clear and distinguishable manner, then each obliquity affords a separate view of an object on the opposite side, and thus an object seems to be multiplied as many times as there are obliquities. The refraction of light is also observable, on a great scale, in relation to our atmosphere. The rays of the sun, on reaching the confines of the atmospheric fluid which envelops the earth, enter a medium of greater density than that through which they have previously passed, and consequently are refracted, or bent. One obvious effect of this is, that we never see the sun in the actual position which he occupies. He always appears more or less raised in relation to our eyes, as was the case with the dollar in the above-described experiment of the basin of water. This is peculiarly the fact in the morning, when his earliest rays meet our eyes. Entering a denser medium, these rays bend round to meet our vision, and we actually see the body of the sun a few minutes before he has

risen above the horizon; like the dollar in the basin, we see him round a corner. In proportion as the sun approaches the zenith, the refraction diminishes; and as he recedes toward setting, it increases. So considerable is it, in the hazy atmosphere of evening, that we retain a sight of the sun's disk after it has sunk. The same phenomena occur in relation to the other heavenly luminaries.

From these explanations, it will appear that the directness of our vision is at all times liable to be disturbed by atmospheric conditions. So long as the atmosphere between our person and the object we are looking at is of the same density, we may be said to see in a straight line to the object. But if, by any cause, a portion of that atmosphere is rendered less or more dense, the line of vision is bent, or refracted, from its course. A thorough comprehension of this truth in science has banished a mass of superstition. It has been found that, by means of powerful refraction, objects at great distances, and round the back of a hill, or considerably beneath the horizon, are brought into sight. In some countries this phenomenon is called *mirage*. The following is one of the most interesting and best-authenticated cases of the kind. In a voyage performed by Captain Scoresby, in 1822, he was able to recognize his father's ship, when below the horizon, from the inverted image of it which appeared in the air. "It was," says he, "so well defined, that I could distinguish, by a telescope, every sail, the general rig of the ship, and its particular character, insomuch that I confidently pronounced it to be my father's ship, the Fame, — which it afterwards proved to be, — though,

on comparing notes with my father, I found that our relative position, at the time, gave our distance from one another very nearly thirty miles, being about seventeen miles beyond the horizon, and some leagues beyond the limit of direct vision!"

Dr. Vince, an English philosopher, was once looking through a telescope at a ship which was so far off, that

he could only see the upper part of the masts. The hull was entirely hidden by the bending of the water; but, between himself and the ship, he saw two perfect images of it in the air. These were of the same form and color as the real ship; but one of them was turned completely upside down.

In the sandy plains of Egypt, the mirage is seen to great advantage. These plains are often interrupted by small eminences, upon which the inhabitants have built their villages in order to escape the inundations of the Nile. In the morning and evening, objects are seen in their natural form and position; but when the surface of the sandy ground is heated by the sun, the land seems terminated, at a particular distance, by a general inundation; the villages which are beyond it appear like so many islands in a great lake; and an inverted image of a village appears between the hills.

The Swedish sailors long searched for a supposed magic island, which, from time to time, could be descried between the Island of Aland and the coast of Upland. It proved to be a rock, the image of which was presented in the air by mirage. At one time, the English saw with terror the coast of Calais and Boulogne, in France, rising up on the opposite side of the Channel, and apparently approaching their island. But the most celebrated example of mirage is exhibited in the Straits of Messina. The inhabitants of the Calabrian shore behold images of palaces, embattled ramparts, houses, and ships, and all the varied objects of towns and landscapes, in the air — being refracted images from the Sicilian coast. This wonderful phenomenon is

regarded by the common people as the work of fairies, and is known by the name of the *fata morgana*.

COLOR BY REFRACTION. One of the most remarkable phenomena attending refraction, is, that the rays of light, which seem to us to be white, may be separated into rays of various colors. It will be obvious that light has the effect of representing colors when no color substantially exists, by noticing the glancing and varied hues on irregular surfaces of glass, ice, or other crystallized substances. The proper method of analyzing the rays of light, and discovering into what colors they may be resolved, is by the use of a *prism*, or three-sided rod of glass. The experiment may be made in the following manner: Into a darkened room admit a beam of sunlight through a hole in the shutter; let this fall upon the prism, and, instead of passing in a direct line through it, and forming a circular white spot upon the wall opposite, the rays will be refracted upwards, and form an oblong image upon the wall, divided into seven colors — red, orange, yellow, green, blue, indigo, and violet. This lengthened image of the sun is called the *solar* or *prismatic spectrum*. No lines are seen across the divisions between the different colors, and it is extremely difficult for the sharpest eye to point out their boundaries. This experiment shows that common white light is compounded of seven different colors, and that they all differ in their powers of refraction; that is, the glass, or whatever medium through which they pass, attracts no two of them with the same degree of force. As they differ in refraction, so also they differ in their powers of *reflection;* and hence arise all the various colors of bodies. Those bodies

which reflect only the red rays, for instance, and absorb all the others, appear red; and so of the other colors. Those which reflect all the rays appear white, and those which absorb all the rays, or nearly so, appear black. Hence it is that black clothes are warmer than any other color, as they absorb more light, and light is never unaccompanied by heat. On the other hand, white is the coolest dress that can be worn.

The *rainbow* is formed by a combined process of reflection and refraction. It is never seen, except when rain is falling between the spectator and the sky opposite the sun. If we look into a globe of glass, or water, held above the head, and opposite to the sun, we shall see a prismatic spectrum reflected from the farther side of the globe. In this spectrum, the violet rays will be innermost, and the spectrum vertical. If we hold the globe on a level with the eye, so as to see the sun's light reflected in a horizontal plane, we shall see a horizontal spectrum with the violet rays innermost; and a corresponding variation will be observed in other positions. Now, since, in a shower of rain, there will be drops in all positions relative to the eye, the eye will receive spectra inclined at all angles to the horizon; so that, when combined, they will form the large, curved spectrum called the *rainbow*. In a very strong sunlight, a *secondary* bow is seen outside of the primary one: the colors are fainter, because the bow consists of rays that have suffered two reflections instead of one. Red rainbows, distorted rainbows, and inverted rainbows on the grass, have been observed. The latter are formed by the drops of rain suspended on the spiders' webs in the fields.

Light is diffused around us by the refractive power of the atmosphere, and therefore objects are quite visible, though the rays of the sun do not strike directly upon them. The atmosphere being thus a vehicle of light, it may be supposed that, if we were to ascend to a great height above the level of the earth, or beyond the atmosphere, we should be almost in darkness, although we were, in reality, nearer the sun. There is reason to believe that such would be the case; for travellers, who have ascended to the summit of Mont Blanc, or about 15,000 feet above the level of the sea, mention that, at that height, the sky appears to be of an exceedingly dark blue color, or almost black, and the light so faint that the stars are visible. We may understand, from this, that the rays of the sun travel through immense regions of darkness before they reach our atmosphere, and are diffused into that universal, soft light which we observe around us.

Reflection adds to the brilliancy of the great mass of light transmitted from the sun. If all the objects on the surface of our planet were black, which is a negation of all color, the sun's light would be absorbed, and we should, even while the sun shone, possess much less light than we now enjoy. But, in consequence of the varied coloring in which our earth is dressed, the sun's rays are more or less reflected, and sent back into the general mass of light. If the object on which the rays fall be clear, and polished on its surface, it will possess the power of representing the image of any object within the reach of its rays. Thus the surface of a smooth lake will represent the image of the sky above, of the neighboring hills, or of any

object floating on its surface. But the phenomena of reflection are too familiar to the reader, to require any very minute description.

A *lens* is a thin piece of glass, or any other transparent medium, having one or both sides either convex or concave. The convex surface magnifies objects, and the concave diminishes them; for, according to the laws of refraction already explained, the rays of light, falling upon a convex lens, are refracted towards its centre, or drawn to a focus; and as the eye judges of the position of an object from the direction in which the rays last proceed, the converging rays will appear to come from a wider extent of space than is real. In a concave lens, the rays, being refracted in a different direction, diverge, instead of converging, and strike the eye as if coming from a narrower space than the reality; for this reason, the apparent size of the object is diminished. Concave mirrors magnify, and convex mirrors reduce objects, on the same principle. The human eye contains a natural convex lens, through which all the rays of light which cause our vision pass, and are brought to a focus on the *retina*, a delicate membrane, lining the back part of the eye; this is connected with the optic nerve, which communicates with the brain — the organ, or centre, of all sensation.

ACOUSTICS.

THE term ACOUSTICS is derived from a Greek word which signifies, *to hear*, and is applied to that branch of natural philosophy which treats of the nature of *sound*, and the laws of its production and propagation.

Atmospheric vibration is allowed to be the cause of sound. For instance, a bell is struck by its clapper; the body of the bell consequently vibrates, as we may assure ourselves by applying one of our nails lightly to the edge: in its agitation, it beats, or makes impulses upon the air, which, yielding under the stroke, or pressure, is compressed, or condensed, to a certain distance around. The compressed air instantly expands, and, in doing so, repeats the pressure on the air next in contact with it, and thus each one of the original strokes of the vibrating metal sends out a series of *shells* of compressed air, somewhat like the waves dispersed over a lake from the dropping of a stone into its placid bosom, and, like them, always lessening in bulk and force. These shells are from 2 inches to 30 feet in thickness. The air they agitate finally reaches the ear, where it gives a similar impulse to a very fine nervous membrane, in the ear, called the *drum*, which communicates with the auditory nerve, and this conveys to the brain the sensation of sound.

With regard to the velocity with which the impulse

of sound advances, it appears, from the most accurate experiments, on the discharge of pieces of ordnance, and marking the interval between the flash and the report, at a distance carefully measured, that, when the atmosphere is at the temperature indicated by 62° of Fahrenheit, sound travels at the rate of 1125 feet per second, which is nearly equal to the velocity of a cannon-ball, the moment it issues from the piece. The ball is very speedily retarded by the resistance of the air, but the sound advances with undiminished velocity, though unequal intensity. It will travel a mile in little more than four seconds and a half, or twelve miles and three fourths a minute.

On this depends an easy method of determining, in many cases, our distance from objects, and which may often prove useful, particularly in thunder-storms. We have only to observe, in seconds, the interval between the flash and the report, and allow four seconds and a half to every mile, or 1125 feet to every second. It is remarkable, also, that all kinds of sounds, strong or weak, acute or grave, advance with the same velocity; and this arises from the circumstance, that all the oscillatory movements in the air, however minute or extended, are performed each in the very same interval of time. For every degree of Fahrenheit above 62°, the velocity of sound is increased one foot and about a seventh; and for every degree below 62°, it is lessened in the same measure; so that, when the temperature is at the freezing point, the rate is only 1090 feet per second.

That water is a vehicle of sound, as well as the air, is proved by various circumstances, particularly by the

fact, that a bell rung under the water can be heard above; and if the head of the auditor be also under water, it will be still more distinctly heard. The sound which the sonorous body produces, however, is graver than that which it gives forth in the air. That the atmosphere is necessary for the transmission of sound is evident from the fact, that a bell rung in the exhausted receiver of an air-pump can scarcely be heard. Smooth bodies form favorable channels of sound; as, for example, the surface of ice, snow, water, or the hard ground. Savages, it is well known, are in the habit of putting their ear to the ground in order to discover the approach of enemies, or beasts of prey.

Tubes convey sounds with great accuracy, and to great distances; and this property has been applied to various useful objects. The most valuable of these purposes is that of examining the chests of persons supposed to possess pulmonary affections. This is done by means of the *stethoscope*, an instrument which resembles a small trumpet. The wide end of the instrument is applied to the body, and the other is held to the ear by the physician, who then has a very clear perception of the sounds caused by the action of the lungs, and can judge whether they be healthy or the reverse. A person of skill can exactly describe the condition of the lungs, from the nature of the sounds that thus reach his ear.

In a public exhibition in London, there has long been shown an apparatus, consisting of a four-footed stand, and several trumpet-mouthed tubes, from any one of which a spectator will receive a ready answer to a question. The answer is said to come from the "in-

visible girl;" and the true explanation of the puzzle is, that a secret tube, in the legs of the apparatus, communicates the sounds to a girl in a neighboring apartment. Sound requires a certain length of time to travel from one place to another.

It is on account of this principle that, in long ranks of soldiers, where two bands of music are placed at a considerable interval from each other, it is impossible for the two bands to keep time. They may, indeed, play together, but each soldier will hear the nearest sounds quickest, and thus they will seem to be out of time. It is often noticed, too, that if, from an eminence, we look upon a long column, which is marching to a band of music in front, the various ranks do not step exactly together. Those in the rear are, in each step, a little later than those before them. This produces a sort of undulation in the whole column, which is difficult to describe, but which all who have noticed it will understand. Each rank steps, not when the sound is *made*, but when, in its progress down the column, at the rate of 1125 feet per second, it reaches their ears. Those who are near the music hear it as soon as it is produced, while the others must wait till sufficient time shall have elapsed for it to have passed through the air to them.

Should a commander stand at a distance of a fifth of a mile from his army, and command them to fire, they might all obey at the moment when the word of command reached them; but the officer will hear the report of the guns from those at the side nearest him first, then those a little farther off, and so on to the most remote. Thus, though all might obey with equal

alacrity, the sounds will not, and cannot, appear simultaneous, for the report of the distant guns must be delayed long enough for the command to pass from the officer to the men, and then for the sound to return. All attempts, therefore, to make the firing appear exactly simultaneous from a long line, must be in vain.

An *echo*, or duplication, of sound, is one of the most interesting phenomena in acoustics. The cause of it is precisely analogous to the reaction of a wave of water. When a wave of water strikes the precipitous bank of a river, it is thrown back in a diagonal direction to the side whence it came, and then again strikes on the bank. In the same manner, the pulses, or waves, of sound are reflected, or thrown back, from flat surfaces which interrupt them, and, thus returning, produce what we call an *echo*. It is evident that the smoother the surface which reflects the sound, the more perfect will be the reverberation. An irregular surface, by throwing back the wave of sound at irregular intervals, will so confound and distract it, that no distinct or audible echo will be reflected. On the contrary, a regular concave surface will be concentrated into a focus capable of producing a very powerful effect. The velocity with which an echo returns to the spot where the sound originates, depends, of course, upon the distance of the reflecting surface; and since sound travels at the rate of 1125 feet in a second, a rock situated at half that distance will return an echo in exactly one second. The number of syllables which we pronounce in a second will, in such a time, be repeated distinctly, while the end of a long sentence would blend with the commencement of the echo.

An echo may be double, treble, or even quadruple, according to the nature and number of the projecting surfaces from and to which the sound is allowed to play. Distinctly-marked echoes of this combined and planned order may sometimes be heard in the vaults of cathedrals — in which case, the waves of sound are driven from side to side of a deeply-groined arch, and reverberate in protracted peals. One of the most interesting echoes of this kind in nature is that which occurs on the banks of the Rhine, at Luxley. If the weather be favorable, the report of a musket fired on one side is repeated from crag to crag, on opposite sides of the river alternately.

There are some remarkable echoes in churches, arising from peculiarities in the construction. In erecting the baptistry of the church of Pisa, the architect disposed the concavity of the cupola in such a manner, that any noise from below is followed with a very loud and long double echo. Two persons whispering, and standing opposite to each other, with their faces near the wall, can converse together without being overheard by the company between. This arises from the elliptical form of the cupola, each person being placed in the focus of the ellipsis. In the cathedral church of Gloucester, England, there is, or was, a whispering gallery about the eastern extremity of the choir, which extends from one end of the church to the other. If two persons placed at distant points speak to one another in the lowest voice, it is distinctly heard. A similar effect is produced in the vestibule of the observatory of Paris, and in the cupola of St. Paul's, London. A tourist has mentioned that in Italy, on the

way to Naples, and two days' journey from Rome, he saw in an inn a square vault, where a whisper could easily be heard at an opposite corner, but not at all on the side corner that was near to you. This property was common to each corner of the room. He saw another, on the way from Paris to Lyons, in the porch of a common inn, which had a round vault. When any person held his mouth to the side of the wall, several persons could hear his whisper on the opposite side.

The whispering gallery in St. Paul's, London, is a great curiosity. It is 140 yards in circumference, and is just below the dome, which is 430 feet in circumference. A stone seat runs round the gallery along the front of the wall. On the side directly opposite the door by which visitors enter, several yards of the seat are covered with matting, on which the visitor being seated, the man who shows the gallery whispers, with the mouth near the wall, at the distance of 140 feet from the visitor, who hears his words in a loud voice, seemingly at his ear. The mere shutting of the door produces a sound like a peal of thunder rolling among the mountains. The effect is not so perfect if the visitor sits down half way between the door and the matted seat, and much less if he stands near the man who speaks, but on the other side of the door.

It is of great importance that buildings designed for large auditories should be constructed in such a manner that the voice of the speaker will neither echo from the walls, nor be lost to the hearers. The best-known form of apartment, for the proper distribution of sound, is that in which the length is from a third to a half more than the breadth; the height somewhat greater

than the breadth, and having a roof bevelled off all round the sides. This species of ceiling, technically called a coved or *coach roof*, from its being lower at the sides than at the centre, is, in all cases, best suited for conveying sounds clearly to the ears of auditors.

MUSICAL SOUNDS. There is a peculiar character in sounds, depending on the nature of the sounding body. A blow with a hammer, or the report of a pistol, produces only a noise. But if a body be of such a thinness and tightness as to produce a succession of impulses of a sufficient degree of quickness, a *tone* is the result—namely, a sound composed of a great number of noises, all so close upon each other that they bring but one result to the ear. Wires and strings of metal and catgut, slips of metal, fine membranes, and columns of the air itself, enclosed in tubes, are the most familiar means of producing sounds of this kind. Such sounds are said to be musical.

The study of musical sounds, as a branch of natural philosophy, is calculated perhaps to give as much pleasure to the man of science as music itself can convey to those who are gifted with what are called good ears. The natural character of these sounds, and their relations to each other, are very remarkable; while the relation of the whole to the human mind must be regarded as one of the most interesting proofs of creative design which the entire circle of nature presents.

The principal sounds in music may be said to be only seven in number. There are other five, which may be produced by the voice with some difficulty; but the voice in an untutored condition gives forth only seven. The notes are of different degrees of shrill-

ness, one rising above another, in succession. A person who knows nothing of music beyond having heard another sing or play, and having seen the key-board of a piano-forte, will be ready to say that there are more notes than seven; but there are only seven that are, strictly speaking, various. The voice, or an instrument, may run up into other notes; but all of these are repetitions of the first seven, and identical respectively with them, in all regards except shrillness. In ordinary piano-fortes, there are at least six repetitions of the seven notes, so that the uppermost keys are more piping than the voice of a child, while the lowest rumble like a drum.

The seven notes are named Do, Re, Mi, Fa, Sol, La, Si, or by the first seven letters of the alphabet, in a peculiar arrangement, namely, C, D, E, F, G, A, B.

There are many curious facts connected with the harmonious notes. The *cries* of a city — that is, the scarcely articulate, but often very musical sounds uttered by persons selling things in the streets — generally rise on thirds or fifths, sometimes on octaves; and this, although few of these poor people have ever been taught music. The cry of oysters by women in Edinburgh is always on an octave. Teachers of elocution are always aware that human beings, in general, make such transitions of voice naturally, under the influence of certain feelings. For example, a person indifferently surprised at hearing a friend say, "I was the person who did so and so," will say, "Was it you?" rising only a third at the last word. If greatly surprised, the rise will be a fifth. There may even be so great a degree of astonishment, that the word "you"

may begin on one note and terminate on its octave. The answer, "Yes, it was I!" will show corresponding declensions or falls of voice. We thus see how truly music is a species of natural language. Unquestionably, every shade of human feeling can be represented by successions of its sounds, apart altogether from its words.

With respect to the sounds produced by wind instruments, the effect is caused by the vibration of a column of air confined at one end, and either open or shut at the other. The length of the sounding column determines the nature of the vibrations; but along with the fundamental tone, there are interior and subordinate vibrations. The whole column divides itself into regular portions, equal to the half, the third, and so on, of the longitudinal extent, in the same manner as is the case in stringed instruments. We may observe something similar to these vibrations in the contraction and expansion of a long and very elastic string, to one extremity of which a ball is attached. A spiral spring also shows, and perhaps more clearly, the repeated stretching and recoil. If suddenly struck at one end, it will exhibit not only a vibration throughout its whole extent, but likewise partial ones, which wind, like a snake, along the chain of elastic rings. If the air be struck with great force, the subordinate vibrations sometimes predominate, and yield the clearest and loudest tones. This may be observed in the dying sounds of a bell, which rise one or two octaves, and expire in the acutest note. Upon the degree of force with which the instrument is blown, depends the performance of the bugle-horn, whose compass is very

small, consisting only of the simplest notes. In other wind instruments, the nature of several notes produced depends upon the length and size of the tube, or the positions of the holes in its sides.

In the organ there is a pipe for each note, and wind is admitted from the bellows to the pipes by the action of keys similar to those of a piano-forte. The organ may be played, also, by a barrel, made to turn slowly under the keys, and to lift them, in passing, by means of pins projecting, at certain determinable intervals, from the surface of the barrel. In wind instruments which are furnished with reeds, the tone depends on the stiffness, weight, length, &c., of the vibrating plate, or tongue, of the reed, as well as on the dimensions of the tube, or space, with which it is connected.

ELECTRICITY.

Electricity, from the Greek word *electron*, amber, properly signifies the science which treats of the phenomena of attraction and repulsion produced by the friction of amber, in which substance these phenomena were first observed. As similar appearances, however, were afterwards observed in sealing-wax, glass, and a vast number of other bodies, the term has been extended so as to embrace the operation of this principle wherever it is found. The property exhibited by amber in attracting light bodies was known more than 600 years before Christ; and Thales of Miletus, in endeavoring to account for it, ascribed to this substance the functions of an animated being. Singularly enough, although this property was known to both ancients and moderns, no experiments seem to have been made upon the subject before the 17th century, when Dr. Gilbert discovered that the electrical attraction resided, not only in amber, but in the diamond and many other stones, glass, sulphur, sealing-wax, resin, alum, &c. After this, experiments and researches were made by many eminent men, among whom were Sir Isaac Newton and Dr. Franklin; and the electric phenomena, connected as they are now known to be by certain well-ascertained laws, form together the most complete and important addition to the physical sciences which has been made since the time of Newton.